# ECONOMIC GEOGRAPHY

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ECONOMIC GEOGRAPHY

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# ECONOMIC GEOGRAPHY

ECONOMIC GEOGRAPHY, in this its first issue, presents a series of articles indicative of the field in which it hopes to serve. The need for a full knowledge of the natural resources of the world, and a better understanding of the natural conditions to which man must the more carefully adapt himself as population increases and the burden upon the land is made heavier, has only recently made itself felt; it is from this need that the new interest in economic geography has sprung.

We are living in a highly industrialized world; the relationships between our resources, their wise utilization, and the common weal, are intricate and devious. Man's conquest of Nature seems more nearly complete than ever, yet in ever increasing measure, Nature's influences become the decisive factors in limiting the activities of men.

We are vitally concerned with the tillable and arable soils; with the forests, the grasslands, the deserts; with the food and fibre-producing plants, the fisheries, the animal life, both feral and domestic; with the metallic ores, the oils, and the fuels; with water power, and routes of trade and travel. As citizens of the modern commonwealth we are prepared to act intelligently on the larger problems of national and international economic and social relationships only when we appreciate the possibilities and limitations of the habitable portions of the earth. A study of geography should lead to a better understanding and a more intelligent sympathy between the various peoples of the world.

Since no journal occupies this field of scientific inquiry in America or abroad, Clark University will publish ECONOMIC GEOGRAPHY with the sincere hope and purpose of making it useful and valuable to all who are engaged in the promotion of industries and trade; to all interested in geography or economics or sociology; to the many students of national and international affairs; and to all who wish to have a part in the intelligent utilization of the world's resources.

The co-operation and active support in this enterprise of eminent experts of this land, and of Canada and Europe, are sincerely appreciated.

ECONOMIC GEOGRAPHY

VOL. I MARCH, 1925 No. 1

# THE RELATION OF GEOGRAPHY TO TIMBER SUPPLY

*W. B. Greeley, Chief*

U. S. Forest Service

EVER since Hiram, King of Tyre, shipped rafts of fir and cedar down the Mediterranean Coast to trade with the Jews of Solomon's day, timber has been an important factor in the commerce of the nations. Among the first exports from the American colonies to the mother country were clapboards split from the oak of Virginia, ship masts cut from the pine forests of New England, and pitch extracted from the piney woods of the South Atlantic. The progress of civilization has been called a struggle between human wants and natural resources. And no part of this age-long contest has been more clear cut than the effort of mankind to supply its need for wood.

Most of the industrially aggressive nations have lived in forested regions, and most of them have been liberal users of timber. The course of these nations in satisfying their requirements for forest-grown materials has usually run through three different stages. At first they have cut freely from their own virgin forests as long as the supply lasted. Then they have cast about for what they might barter from their neighbors. And finally they have settled down to the systematic growing of wood on all the land that could be spared for the purpose, still finding it necessary or convenient in many cases to import a substantial part of their national requirements from other countries whose virgin forests have not yet become depleted or whose timber culture produces an exportable surplus.

Man-grown timber, however, is costly, while timber stored up in nature's undrained warehouses is cheap. The source of supply is thus largely governed by the cost of growing timber at home as compared with the cost of hauling it from the nearest virgin forests still available for exploitation. In the long run, forestry is pitted against transportation.

The United States is still in the first of these three stages. By far the greater part of the wood we use is still obtained from our own virgin forests. But the end of this supply is plainly in sight. The necessity is at hand of finding a new source of wood, either in timber culture on our own soil or in the forests of other countries. The consumption of timber in this country is so enormous that the problem assumes staggering proportions. We use annually about 12 billion cubic feet of saw-log timber, or nearly half of the quantity consumed in the entire world. Our use of all forest products, including pulpwood, railroad ties, mine timbers, and fuel wood, aggregates 22½ billion cubic feet, or about two-fifths of the yearly consumption in the entire world.

Other countries which have likewise exhausted their virgin forests have found new sources of wood either in the practice of forestry or through imports from their neighbors or by combining both of these methods, without sudden industrial upheavals or serious timber famines. Their consumption of forest products has been relatively small; the change was

gradual and usually involved no great difficulty. The enormous use of wood in the United States, however, and its intimate relation to national living standards, manufactures, and basic industries like agriculture, mining, and transportation, make our problem far more serious. We must find, almost overnight, a fresh source of raw material sufficient to supply 60 or 70 million tons of forest products annually. Instead of a gradual industrial evolution, the change is coming with the suddenness of an economic crisis (Fig. 1).

The forest history of the United States strikingly illustrates the relation of geography to timber supply. To the colonists and explorers of the seventeenth century, America appeared a vast, unbroken forest. Even after geographers had mapped the full extent of the prairies and western deserts, they found that nearly half of her total land area, or more than 820 million acres, was originally in forest (Fig. 2). Although the export of timber products began in the early days of the Atlantic colonies, for several generations the forest represented a barrier to settlement and migration rather than an economic resource. Nothing could have appeared more remote than a shortage of timber. About 200 million acres of our original forest area have been cleared for cultivation and settlement, and the stumpage removed from three-fourths of this land was destroyed for lack of a market.

When the manufacture of lumber at little sawmills, run by water power, became a fairly established industry, there was no lack of the finest raw material at their very doors. Lumber was moved but very short distances and its cost was exceedingly low. In 1736 pine lumber prices in New England were commonly around $5.00 per thousand board feet. Between 1799 and 1834 pine lumber cut on the Kennebec River in Maine was sold on the Boston market for from $10 to $14 per thousand board feet. Slowly, very slowly, the frontier of virgin forest began to move back from the centers of population, and, as the sawmill followed its retreat, the element of transportation entered into the cost of forest products.

Up to the time of the Civil War, short and cheap lumber hauls, almost wholly by water, characterized our timber traffic. Lumber or logs moved down the Atlantic Coast from Maine to Boston, about 225 miles, from the upper Hudson to New York, not over 200 miles, and from the shores of the Great Lakes into Buffalo and Chicago. The rafting of the Pennsylvania rivers rarely covered more than 400 miles; and the bulk of the products of "Penn's Woods" moved much shorter distances, as from Williamsport to Philadelphia. One or two or three dollars at the most paid the freight bill on a thousand feet, and the consumer's price was correspondingly low. Even up to 1902, the short local shipments from the Lake region held cargo prices on white pine boards at Chicago down to $16 per thousand feet or less.

The change came with the railroad building and industrial expansion that followed the Civil War. Lumber manufacture ceased to be a village industry. It caught the spirit of "big business" and rapidly forged into the lead with large organizations, tremendous capitalization, and the efficient tools of quantity production. It reached out with unequaled driving power in manufacture and merchandizing. It taught the American people to use wood in prodigious and unheard-of quantities. In 1840 the per capita consumption of lumber probably did not exceed 100 board feet. By 1906 it had become 516 board feet. Behind the sawmills came the paper mills, using more and more wood until it now forms 90 per cent of their raw material. Through their energetic attack upon the forests another great national appetite for wood has been created. The per capita consumption of paper has increased five-fold since 1840. Then came the veneer plants, the distillation plants, the vehicle and agricultural implement factories, the makers of railroad ties and telegraph poles, and

FIGURE 1.—The United States must shortly find some means of replenishing the storehouse of splendid virgin timber whose end is in sight. (Photo from U. S. Forest Service.)

a hundred industrial developments with their greater or lesser demands for timber. The exploitation of virgin forests has been a foremost contributor to the economic growth of the United States during the last 70 years.

It was inevitable that our timber resources should shrink rapidly before this terrific onslaught. The story is told in the maps showing the approximate extent of the virgin forests in 1620, 1850, and 1920 (Figs. 2, 3, and 4). The first

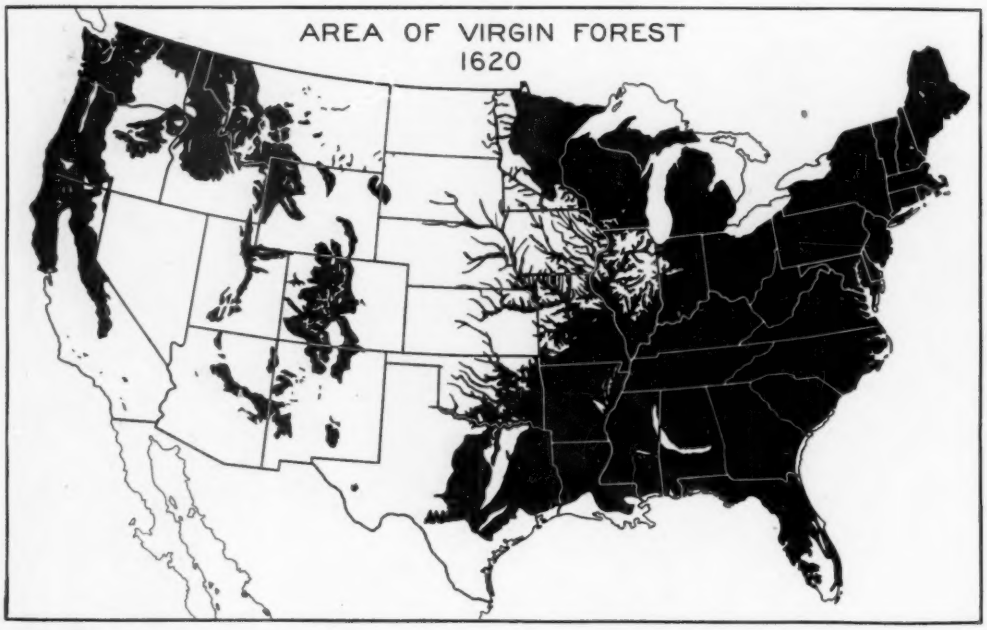



FIGURE 2.—When the early colonists settled along the Atlantic Coast nearly all the country east of the Mississippi River, and much land to the westward, notably in Arkansas, Louisiana, Texas, and the Pacific Northwest, was covered with a vast virgin forest,—about 820 million acres in all. (Map from U. S. Forest Service.)

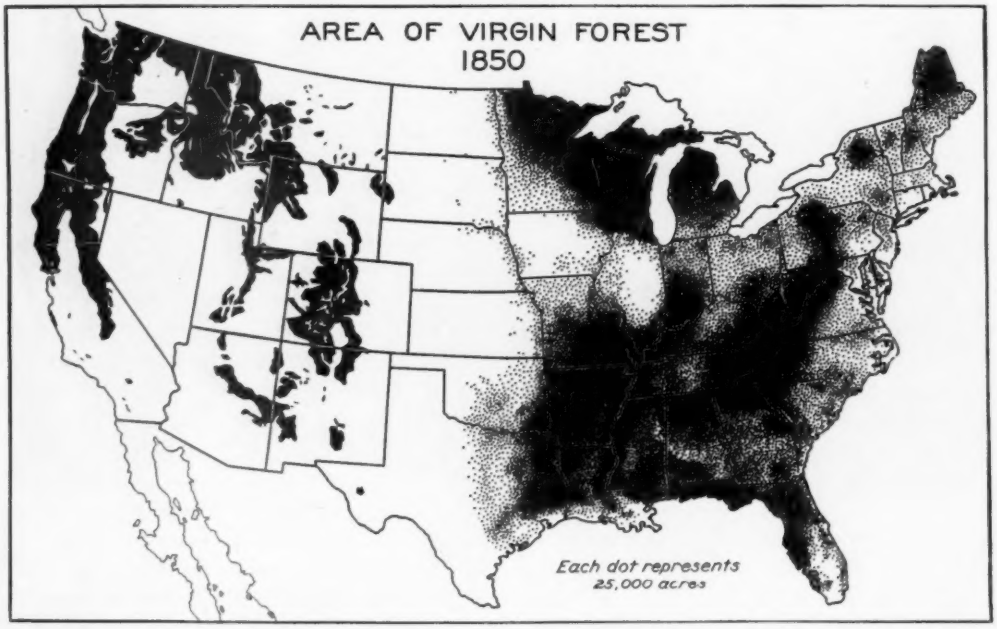



FIGURE 3.—Even in 1850 much of the forest in the eastern United States was still in a virgin condition, and the forests in the Rocky Mountain and Pacific states had scarcely been touched by man. The map was based on estimates by states and the dots are not all correctly located. Northwestern instead of south central Ohio should be densest, as the Black Swamp was almost a solid forest in 1850. Northern Indiana should likewise show a denser distribution of virgin forest, and in southern Indiana, where settlement first occurred, the dotting should be thinner. (Map from U. S. Forest Service.)

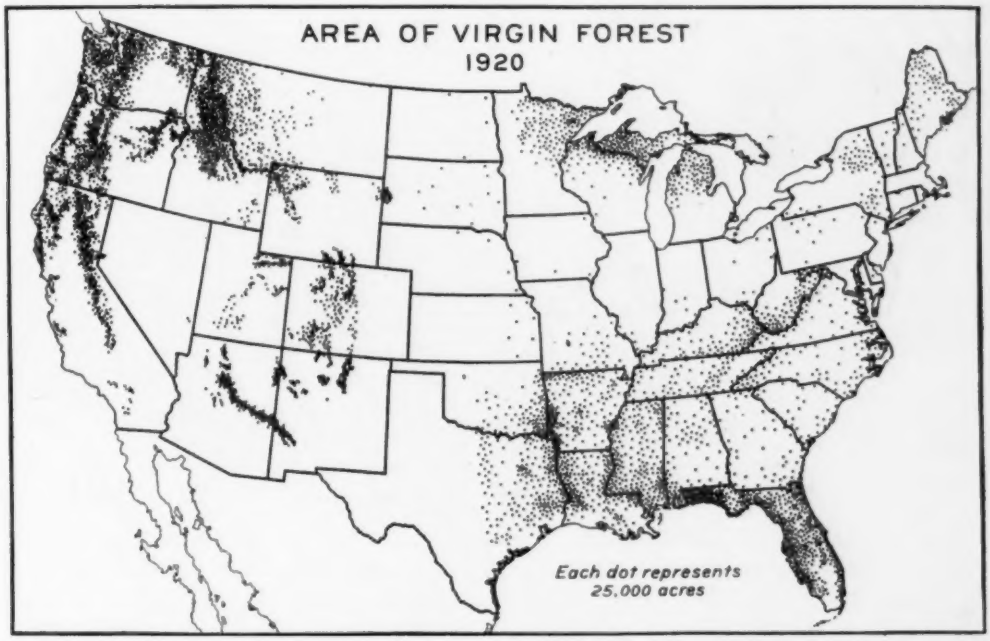



FIGURE 4.—By 1920 the area of virgin timber in the United States had been reduced to about 138 million acres, of which more than half was in the Rocky Mountain and Pacific Coast states. Culled and second growth trees of sufficient size for lumber covered about 114 million acres more, and there were about 136 million acres of forest having small young growth or trees of cord-wood size. In the United States in 1920 the amount of virgin timber has been estimated at 1,600 billion board feet, and the culled and second growth stands at 600 billion feet, a total of 2,200 billion feet, as compared with probably 5,200 billion feet originally. Over half of this remaining saw timber is in the Pacific Coast states. (Map from U. S. Forest Service.)

230 years of settlement and industrial expansion made relatively slight inroads. In the last 70 years the depletion of our timber supply has gone on apace. And as the virgin forests disappeared, the relation of geography to timber supply has become more and more pronounced. It is summed up in the cost of transportation from the standing tree to the user of its products. From the economic viewpoint, our forest history is a record of widening gaps between the consumer of lumber or paper and the source of his supply (Fig. 5).

As long as Maine, New York, and Pennsylvania were the foremost lumber-producing states, lumber was cheap in the great markets of the country, primarily because the hauls were short and largely by water. When the center of lumber manufacture moved to the Lake States in the 80's and 90's, the era of the box car as a lumber carrier began. Freight rates were long tempered by water transportation on the Lakes, through the Erie Canal, and down the Mississippi; but at that it cost $6 or $7 per thousand feet to ship lumber a thousand miles from Saginaw to New York, by water, or treble the old rate on Hudson River pine. As steadily as the more accessible virgin forests went through the hopper, the railroads gained ascendancy in lumber traffic, the hauls lengthened, and average retail prices rose from one level to another.

During and following the 90's, the pineries of the Lake States rapidly approached exhaustion and the center of the national supply of softwood lumber shifted to the South. Rail shipments in excess of 750 miles and freight bills of $8 or $10 or more per thousand board feet became common. As southern pine gradually secured control of the Chicago market, lumber prices advanced to 75

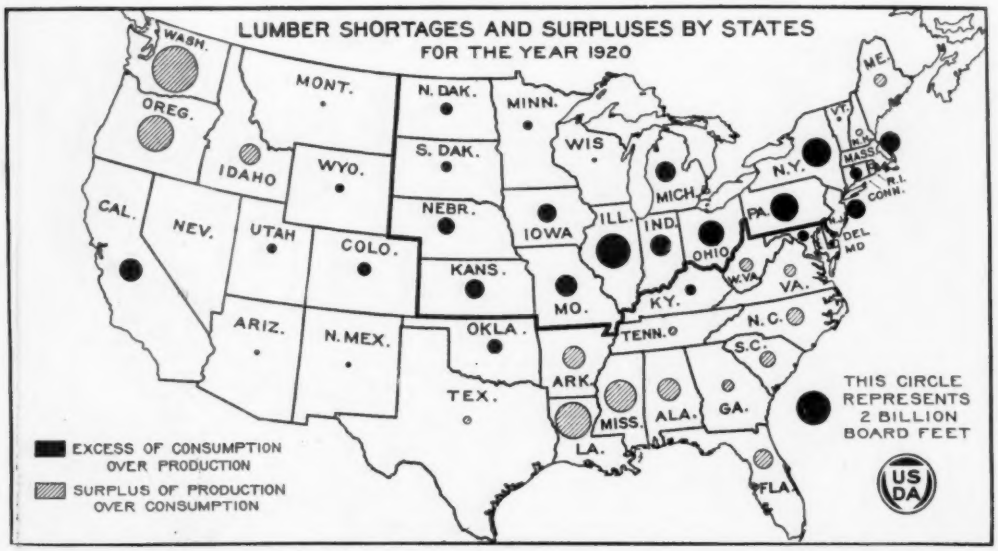



FIGURE 5.—Our greatest industrial and food producing regions—the area north and east of the heavy line—cut only 23 per cent of the lumber they use, and must ship in 77 per cent, chiefly from the South and far West. (Map from U. S. Forest Service 1922 yearbook, U. S. Dept. of Agriculture.)

or 100 per cent beyond the old rates fixed by water transportation from Michigan or Wisconsin mills. Southern lumber moved 1,100 miles to Pittsburgh and 1,500 miles to Boston, at freight rates which, since the World War, have ranged from $12.50 to $15 per thousand feet. Retail prices necessarily climbed to a higher level, but only as a stepping stone to what has followed as the last chapter in the exploitation of our virgin forests is being written.

The virgin pineries of the south covered 130 million acres and contained probably 650 billion board feet of saw timber (Fig. 6). They formed one of the richest reservoirs of softwoods on the earth's surface, and for the past thirty years they have been the mainstay of the eastern and central lumber markets of the United States. But the process of timber depletion is running its course in the south as it has previously been run in the Lake States and the Alleghenies. The production of southern pine lumber passed its peak in 1916, and the last great migration of American sawmills is under way—across the Great Plains to the virgin forests of the Pacific Coast. In 1920 over 600 million board feet of western lumber was shipped to New England and over 1,200 million feet was marketed in Illinois, Michigan, Wisconsin, and Minnesota. In 1923, 34 per cent of our entire lumber cut was manufactured on the Pacific Coast as compared with 36 per cent in the southern states (Fig. 7). Western lumber is now moving in a steadily increasing volume 2,000 or 2,300 miles by rail to the Middle West at a freight cost of $17 or $18 per thousand board feet, and 7,000 miles by sea and the Panama Canal to northern Atlantic ports at a charter rate of $14 or $15 per thousand feet. Lumber manufactured on Puget Sound is now, indeed, moved by steamer to Chesapeake Bay and reshipped inland, past the old sawmill towns of the Alleghenies, as far as Pittsburgh and Cincinnati.

Every year the cost of transportation enters more largely into the lumber bills paid by the American home builder or the American factory (Fig. 7). Two-thirds of the lumber which we use is consumed in the Central and Eastern States. The lumber traffic in 1920 exceeded 1,660,000 carloads and cost, in freight and charters, over $250,000,000. The average carload was hauled 485

FIGURE 6.—A pine forest in southern Georgia. These southern pine forests have provided most of the lumber used in the North during recent years, but the supply is now approaching exhaustion. (Photo from Natural Vegetation Section, Atlas of American Agriculture, U. S. Dept. of Agriculture.)

miles. Between 1914 and 1920, the average rail haul on lumber was lengthened by more than 30 per cent, and the total yearly freight paid on lumber shipments advanced $100,000,000.

These mounting costs for transporta-

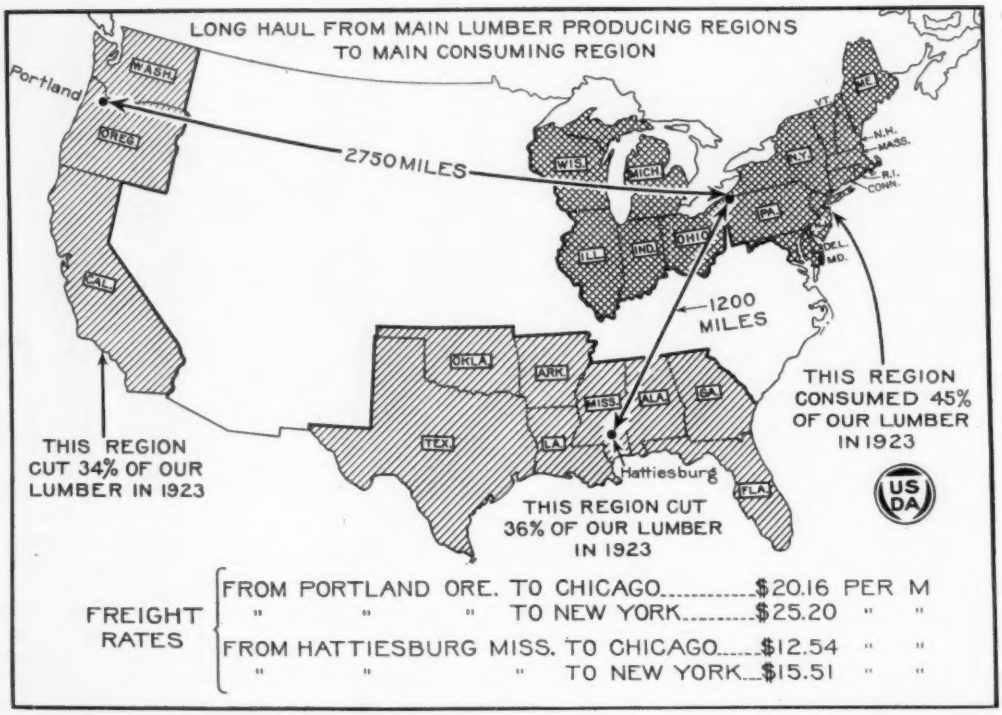
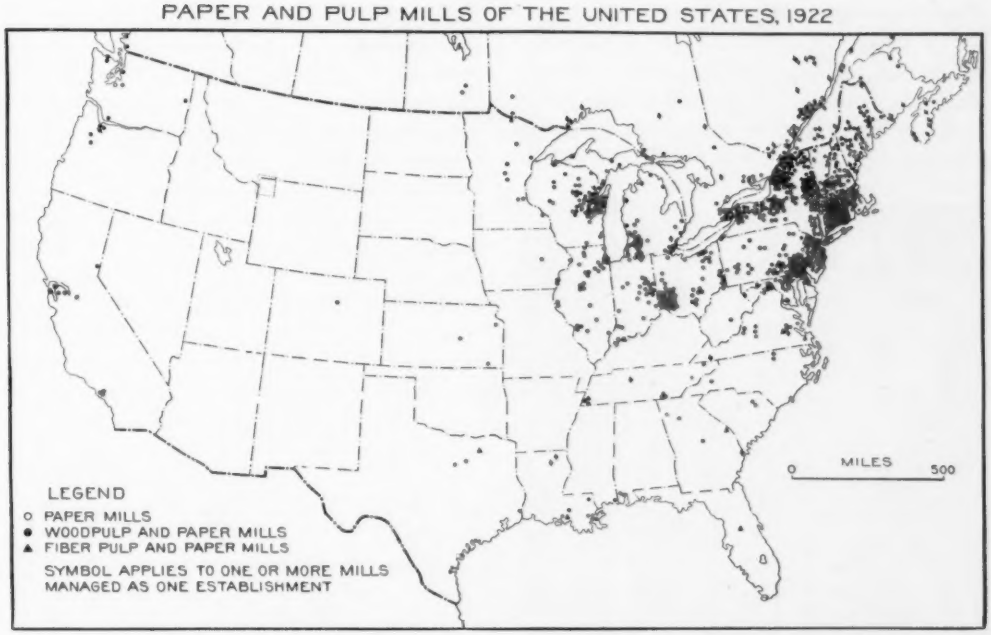



FIGURE 7.—The northeastern quarter of the United States consumes nearly one-half the lumber produced in the United States. More and more of this lumber must come across the continent from the Pacific Coast, or else by the Panama Canal. The cost of freight is $12 to $25 per thousand feet, and the cost to the consumer is increased much more than this by distributors' costs and profits. (Map adapted from 1922 Yearbook, U. S. Dept. of Agriculture.)

tion underlie the rise in lumber prices. Costs and profits in retail distribution tend to pyramid upon every increase in freight. And as the sawmills become more largely concentrated in distant and restricted regions, the competitive movement of lumber into consuming markets is curtailed. Retail prices seldom fail to advance in response to such opportunities. The story of lumber prices in a group of Minnesota towns is illuminating. In 1905, 91 per cent of their supply came from the Lake States. The average freight cost was $3.25 per thousand feet and the average selling price was $26.00. In 1921, over 92 per cent of the lumber handled in these towns came from the Pacific Coast. The average freight bill was $18.12 per thousand feet and the average selling price $53.58. Transportation cost had increased from 12½ per cent to 34 per cent of the retail price, but the actual cost to the consumer, it will be noted, had more than doubled.

In fact, the prices paid by the average user of every day construction lumber the country over have more than doubled within the last twelve years. The very freight paid on lumber is now often more than its delivered price thirty years ago. Hence it is not difficult to understand why lumber prices have advanced, during the last eighty years, three and a half times as rapidly as the index price based upon all staple commodities. It took $510 in 1921 to buy as much lumber —and poorer lumber at that—as $100 bought in 1840.

The story of the American paper industry is somewhat different but reflects no less clearly the extent to which our virgin forests have been depleted. Paper manufacture requires exceptionally heavy plant investments. Hence it has


PAPER AND PULP MILLS OF THE UNITED STATES, 1922
LEGEND
○ PAPER MILLS
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▲ FIBER PULP AND PAPER MILLS
SYMBOL APPLIES TO ONE OR MORE MILLS MANAGED AS ONE ESTABLISHMENT
0 MILES 500

FIGURE 8.—Owing in part to the great expense of installing a plant, in part to the ability to utilize small second growth timber, and in part to the preference for certain coniferous woods, paper and pulp mills have not followed the lumberman into the South and far West to any notable extent. As a consequence, these mills are compelled to depend upon Canada for a substantial part of their supplies. (Map from U. S. Forest Service.)

not followed the retreating frontier of virgin forests to nearly the same extent as have the sawmills, but has remained largely concentrated in the northeastern states (Fig. 8). As a consequence, the raw material available on American soil has been wholly unable to sustain our increasing consumption of paper. Of the eight million tons used in the United States in 1922, 53 per cent came from foreign countries in the form of pulpwood, manufactured pulp, or finished paper. Thirty-seven per cent was imported from Canada alone, including over one million cords of raw pulpwood. The cost of the pulpwood delivered at American plants, much of which is now hauled excessive distances, has probably increased even more rapidly than the price of lumber. In satisfying its needs for this important forest product, therefore, the United States has already outstripped the resources of her own virgin forests. She has been driven to the paper and pulpwood markets of the world.

The stern facts of geography have largely controlled these past developments in our forest industries and in the cost of their wares to the American consumer. The true measure of timber supply is not quantity but availability. Sixty per cent of all the wood that is left in the United States and 75 per cent of its virgin timber lie west of the Great Plains, whereas two-thirds of the population and an even larger proportion of our agriculture and manufactures are east of the Great Plains. The forests bordering the Pacific Coast contain over a trillion board feet of virgin stumpage (Fig. 9). At the most, they will not supply our present consumption very long: but already the unbalanced geographical distribution of this resource is creating well-nigh famine prices in the parts of the United States where forest products are used in the largest quantities. Dependence upon the softwood forests of Siberia as the principal source of supply would differ from our present situation only in degree.

And as geography controls the cost of the products of virgin forests when they reach the ultimate consumer in Massachusetts, Illinois, or Florida, so will geography control the substitution of other sources of timber supply. Most of the

FIGURE 9.—A virgin forest in the Pacific Northwest. These coniferous forests now constitute our last great timber resource. (Photo from U. S. Forest Service.)

other countries have progressed from one stage to another in their source of wood more or less as single geographical units. In the United States the distances are so great and the local conditions so diverse that this transition is bound, for some time to come, to be regional rather than national. We have already seen that, owing to the concentration of the paper industry in the northeastern states, more than half of our consumption of wood fiber products is now drawn from foreign sources. And by the same token, the exigencies of the portions of the country farthest removed from the dwindling frontier of virgin forests are driving them to a new source of wood, namely the timber crop.

Forestry is the economic competitor of transportation. As long as cheap virgin stumpage available at no great distance dominated our lumber and paper markets, there was no place in the economic scheme of things for systematic timber growing. But once the cost of transporting forest products from the nearest virgin sources exceeds the cost of growing them at home, timber culture not only becomes economically feasible but sooner or later is impelled by purely commercial forces. This is just what is taking place today, to a limited degree, in New England, New York, Pennsylvania, and New Jersey; and, to a still more limited degree, in the South. Second growth white pine in New England, 30 or 40 years old, is worth from $10 to $18 per thousand board feet standing in the woods (Fig. 10). Second growth southern pine of the same age brings from $8 to $12 on the stump. With such returns before them and with

FIGURE 10.—A second growth pine stand in New England. Such forests, many of which have grown up in old fields, demonstrate that commercial forestry pays. (Photo from U. S. Forest Service.)

timber values constantly moving upward, hard-headed business men realize that forestry pays. One might almost plat the process by a series of geographical zones; and show that when the freight rate into any consuming region from the nearest large supply of virgin timber passes the $10 or $12 mark, an economic basis for timber cropping is afforded and forestry slowly finds a place in the use of land (Fig. 11).

FIGURE 11.—The answer to forest depletion: the timber crop is already appearing on old cuttings in the southern pineries. (Photo from U. S. Forest Service.)

Forest conservation in the United States hitherto has been largely a matter of public ownership of timber land and public policies based not upon costs and profits but upon foresight of coming national necessities. Today it is percolating down into the counting house and the directors' board room. The illusion of inexhaustible virgin forests has spent itself. Wood-using industries recognize the alternatives which they face—*producing* their future raw material or passing out of existence. A committee of pulp and paper manufacturers is studying ways and means of perpetuating their industry on American soil. A committee of turpentine and rosin producers has visited France to learn the naval stores forestry of the Landes and how it may be applied to our southern pineries. These are signs of the times.

Like the other nations in similar plight, we must barter for all the timber we can secure from our neighbors. The prospects in this direction, however, are not encouraging. Our present exports and imports of lumber and other forest products nearly balance. The imports can undoubtedly be increased somewhat, particularly of paper from Canada and of lumber in limited quantities from certain Canadian provinces and from Mexico. The hardwood forests of South America and the softwood forests of Siberia hold out possible sources of relief. But a number of other industrially aggressive nations are in the same situation as the United States. A recent survey [1] of the principal forest resources and wood-using

[1] Zon and Sparhawk, *Forest Resources of the World*, 1923.

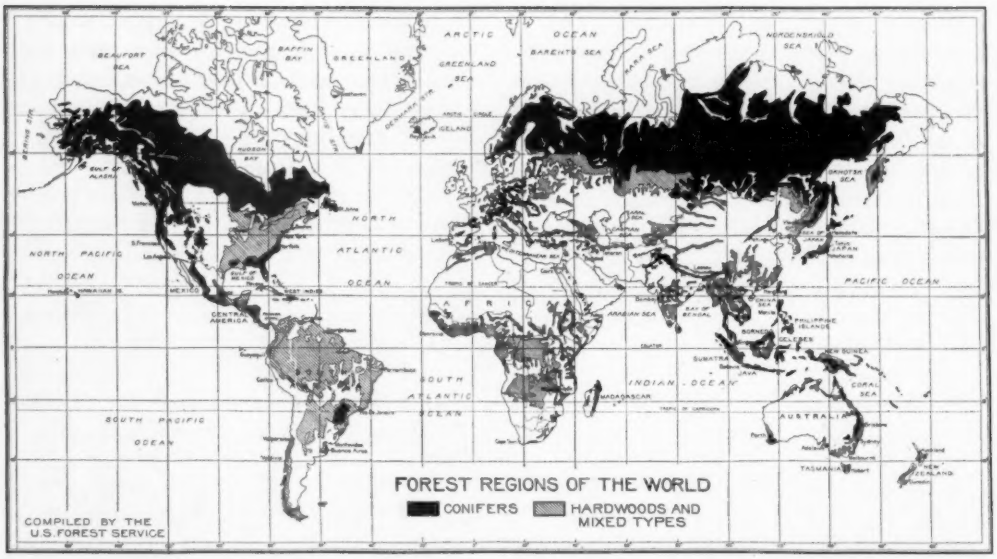


FIGURE 12.—The coniferous forests of the world, which supply nearly all of the softwood timber, are practically confined to the north temperate zone. The map, however, a Mercator projection, greatly exaggerates the extent of this coniferous forest. Moreover, much of the area shown in black consists of timber so small or stunted as to be fit only for firewood and pulp. The cut of saw timber at present in the United States is about as great in all other countries of the world combined, but an annual growth is only about sixteen per cent of the world total. (Map from "Forest Resources of the World" by Zon and Sparhawk, McGraw, Hill Book Co., 1923.)

countries of the world shows that the markets of the whole earth are short of raw materials for paper and construction lumber, and that the accessible supply of timber, particularly of coniferous timber, is not adequate to meet the requirements of modern civilization. The cost of transporting Asiatic or South American lumber to the United States, added to prices at the source fixed by keen international competition, would be wellnigh prohibitive for ordinary construction or industrial purposes (Fig. 12).

Nevertheless we must get all the foreign wood that we can to tide over the lean years, and we must go after it intelligently and systematically. For one thing, a thorough study should be made of the resources available in the hardwood forests of Central and South America and their utility for the replacement of our rapidly waning supply of native hardwoods.

Undoubtedly we must and will learn to use less wood. The high cost of lumber has already decreased its per capita consumption in the United States about 40 per cent below the peak of 1906 (Fig. 13). Steel, cement and clay products have been substituted for much of the construction lumber formerly used; and coal, oil, and electricity have taken the place of much fuel wood. These substitutions are increasing, as wood becomes more dear; and it is well that they should. On the other hand, the use of wood is constantly widening as the chemist and engineer discover new methods of converting or fashioning it for modern requirements. Wood is now manufactured into grain alcohol and artificial silk, even into baking powder and electrical conduits. The field for wood fiber products is constantly enlarging. Notwithstanding the substitution of other materials and the curtailed use of wood for many of its old functions, the total drain upon our forests thus far has not materially lessened. The danger lies not in reducing the use of wood where satisfactory substitution is possible, but in the growing shortage for many essential needs for which there are no substitutes. In most of the industrial countries of Europe the per capita con-

sumption of wood is not diminishing, but increasing; and the United States cannot expect permanently to follow a different course if it is to hold its living standards and retain its industrial leadership.

One of the most essential constructive remedies is to reduce the drain upon our forests by reducing the waste in the manufacture and use of their products. The very abundance and cheapness of virgin timber in the United States has bred wasteful methods of logging, manufacture, and refabrication which are yielding but slowly to the pressure of scant supply and high costs. The general application of even our present knowledge of waste elimination in logging, milling and refabricating lumber, in timber preservation, in the conversion of wood into fiber products and the like, would reduce the current drain upon our forests by 20 or 25 per cent. And we still have much to learn before all the possibilities of economy in the use of our forests are fathomed. The elimination of preventable losses from forest fires and from destructive insects and tree diseases would save an enormous total of useful timber. A cord of wood saved is equal to a cord of wood grown. And one of the most obvious things that should be done with all possible dispatch is to conserve our existing timber supply to the last foot by research in the conversion and use of forest products on an adequate scale, accompanied by wide dissemination of its results through the forest industries and forest consumers.

After everything else has been said, no solution of our forest problem is possible without the generous growing of trees. We must come, in the last analysis, as every other country treading the same path has come, to forestry as the necessary and economic employment of much of our land. This solution is as complete as it is inevitable. Intensive timber culture on the 470 million acres of forest land in the United States, timber culture on a par with that of Germany, France and Scandinavia, can produce a yearly crop equivalent to more than all the

RELATION OF RETAIL LUMBER PRICES TO PRODUCTION AND CONSUMPTION

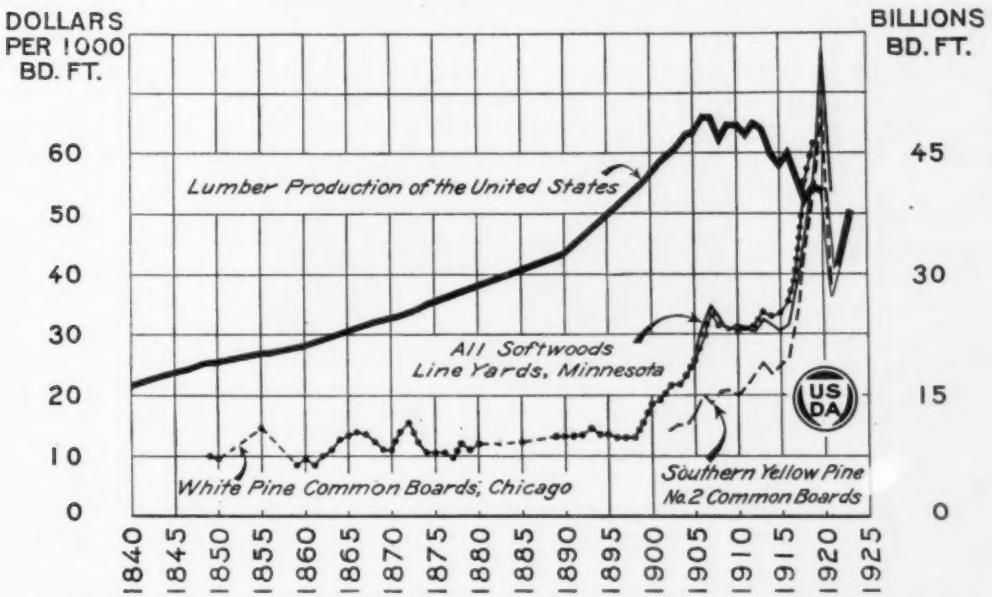


FIGURE 13.—The United States still has mills and timber capable of producing a cut equal to that of 1907; but prices of lumber are now so high and transportation so costly that the consumer cannot afford to buy as much lumber as he once did. (Chart adapted from 1922 Yearbook, U. S. Dept. of Agriculture.)

wood which the United States now consumes. There will be a margin of 20 per cent or more to take care of the greater requirements of the future. The only question is how quickly can this be brought to pass and how much national suffering must be endured before a perpetual supply of timber is assured on our own soil. National habits in the use of land and its resources change slowly; and at best we must travel a slow and painful road before the goal is reached.

Underlying this whole question is one of the outstanding facts of the economic geography of the United States, namely, that one-fourth of her soil remains today, after three centuries of settlement and expanding agriculture, *forest land*. There is small prospect that the area available for growing trees will be reduced materially, if at all, for many years to come. While the inroads of the farm are continuing here and there, the great tide of forest clearing for cultivation seems largely to have spent itself. For many years indeed, the abandonment of farm land in forest growing regions of the older States has practically offset new clearing on the agricultural frontier.

Wholly aside from the need for timber, the problem of keeping one-fourth of the soil of the United States productively employed is one of no small urgency in the national economy. The idleness of cutover land, following the migration of the sawmills, has already been a widespread cause of depopulation, decline in taxable values, and general rural bankruptcy. In the busiest timber manufacturing regions of a few decades ago, there remain today over 80 million acres of practically unproductive and unused land. No country can afford such wastage.

Forestry not only is the only way to re-establish an adequate source of timber in the United States: it is the only way to utilize a large part of her land—to maintain a vigorous rural population with industries, communities and good roads. On both counts, forestry should become part and parcel of our program of land utilization.

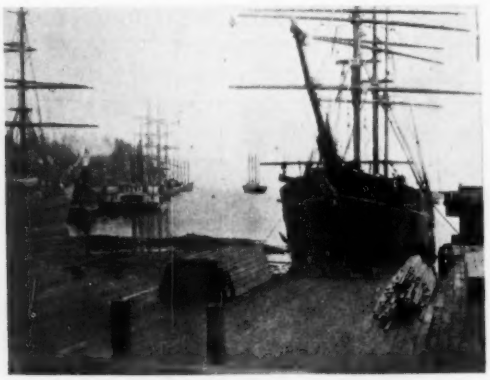

FIGURE 14.—Lumber cargoes from Puget Sound are fast becoming the main source of supply for the north Atlantic seaboard. (Photo from U. S. Forest Service).

# THE POTENTIAL SUPPLY OF WHEAT

*O. E. Baker*

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THE spread of wheat production during the past century across the virgin and fertile prairies of the United States and Canada, Argentina and Australia, Russia and Siberia, is a romantic and fascinating story, but its profound significance has not been fully apprehended. Hundreds of ponderous tomes have been written about the Industrial Revolution in western Europe and eastern North America, which ushered in our modern civilization and has been considered its basis; but scarcely a volume has described the Agricultural Revolution in eastern Europe and western North America, which transformed the grass lands into grain lands and supplied the food and fibres that made the Industrial Revolution possible.

Prior to the nineteenth century agricultural settlement in Europe and North America had been confined by geographic conditions largely to originally forested lands. The forests supplied fuel and building material, and the ever-running streams that are found in forest areas provided drink for man and beast. Most of the grass lands of these continents were grazing grounds for nomads,—Hungarians, Turkomans, and Tartars in southeastern Europe, Indians and later cattle and sheepmen in western North America. The lack of wood and water prevented the utilization of these grass lands for agriculture, and the establishment of civilization. When Malthus wrote his famous essay a century and a quarter ago, predicting that in the occidental world, as in the oriental, population would soon press upon the food supply, and be limited by war, famine, and pestilence, only a small part of the vast prairies and steppes of southern and southeastern Russia had been broken for wheat; the Hungarian Plain was still mostly a verdant pasture, divided into the large estates of nobles and cattle kings; the prairies and plains of central and western North America had not yet been crossed by a white man; the pampas of Argentina were an unmapped wilderness; and only a fringe of land along the coast of Australia had been explored (Fig. 1).

The utilization of these grass lands of the world for grain, supplemented by the use of animal manures and mineral fertilizer on some of the forest soils, has provided for an increase of population in Europe during the past century and a quarter from 200 millions to over 450 millions, and in the United States and Canada from 6 millions to over 120 millions (Fig. 2). Moreover, fully half of these 570 millions of people were, before the recent war, enjoying a standard of living fully twice as costly as that permitted their ancestors a century ago.

Three great inventions account in large measure for the agricultural development of these grass lands and the marvelous and unprecedented increase in population and wealth which has followed,—(1) the invention of well-drilling appliances, (2) the development of grain-harvesting and threshing machinery, and (3) the invention of the steam locomotive and construction of railways. Wells gave water to the trackless wastes, grain-harvesting machinery enabled one man to do the work of ten, and the railroads brought wood and coal to the settlers and provided cheap and rapid transportation to market for their grain and other products.

## THE FOOD PROBLEM OF THE FUTURE

Today we are at another critical period in the history of the occidental world,

much like that existing in England when Malthus wrote his famous essay, but vaster in its significance. In eastern Europe, in western North America, in Argentina, in Australia, almost everywhere among the peoples of the Orient for centuries past.

How is the western world to avoid this impending disaster? Will the twentieth century witness the agricultural exploitation of the tropics, like that of the grass lands of the temperate zones during the nineteenth? Or will the greatly increased use of fertilizers, the prevention of plant diseases, the more careful cultivation of the crops, permit the utilization for wheat and other crops of the poorer lands now in pasture or forest or lying idle, and also cause such an increase in the yield per acre of the lands already in cultivation, as will meet the needs of the more numerous population? Or will the decline in religious authority and development of materialism diminish the birth rate, possibly even induce depopulation eventually, as it did, apparently,

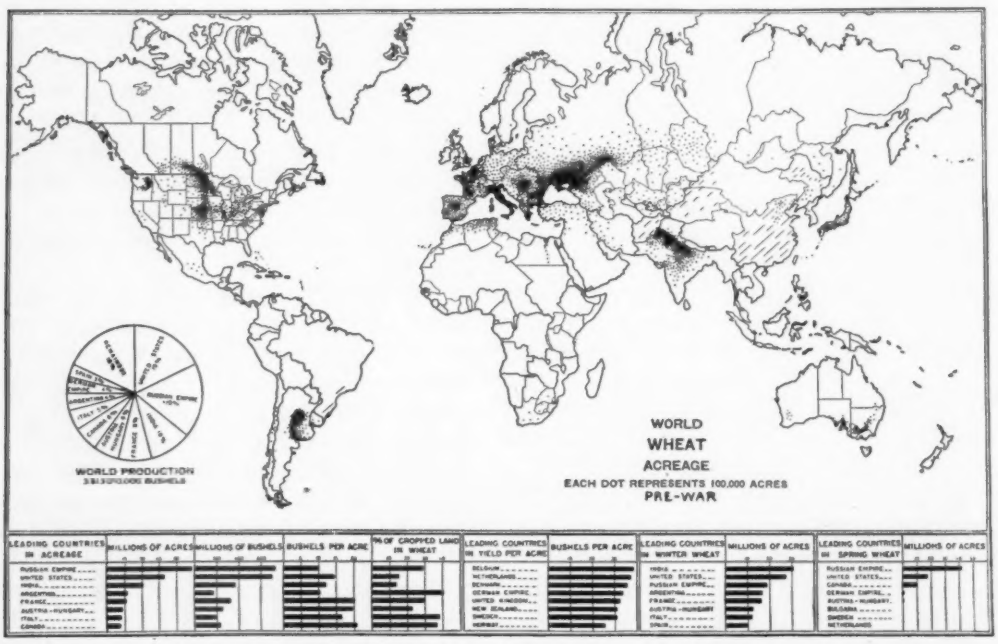



FIGURE 1.—Nearly all the great wheat regions of the world,—the winter wheat district of Kansas, Oklahoma, and Nebraska, the spring wheat district of Minnesota, the Dakotas, and the Prairie Provinces, the mixed winter and spring wheat district of eastern Washington and Oregon, the Argentina area in South America, the Po Valley in Italy, the Hungarian Plain, Roumania, Southern Russia, Western Siberia, Australia, and much of the wheat region of India were prairies. These grasslands, except those of Italy and India, were transformed into grain lands mostly during the Nineteenth Century. (Map from "Geography of the World's Agriculture," by Finch and Baker, U. S. Dept. of Agriculture, 1917.)

where in the temperate zones the rising waves of population are beating against the barriers of adverse physical conditions all along the shore-line of settlement. Only in Siberia does there appear to remain any large amount of arable land yet unutilized for crops outside the tropics; and if the arable land of Siberia were parcelled out among the peasants of Russia each would have an allotment probably less than half that held by the average farmer in the United States. There rises before the eyes of intelligent men today the same vision that rose before the eyes of Malthus—a vision of human misery and degradation like that

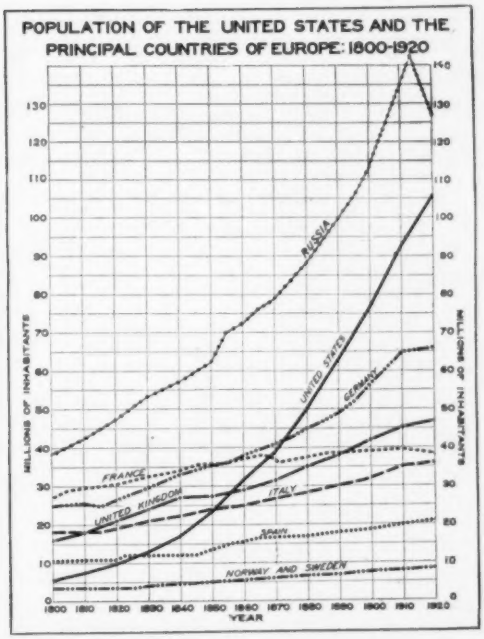



FIGURE 2.—Owing in part to the importation of grain from the former grasslands of the world, and in part to agricultural improvements at home, principally the use of animal and mineral fertilizers, the population of Scandinavia, of Spain, and of Italy doubled between 1800 and 1920, while that of the United Kingdom and Germany almost trebled. Only France failed to increase notably in population. During the same period agricultural expansion in the United States permitted a twenty fold increase of population (from five millions in 1800 to 106 millions in 1920). The increase in European Russia (including Russian Poland and the Caucasus) was from 36 millions in 1796 to 143 millions in 1913. As a result of war, famine and disease, the population in this area had decreased to about 127 millions in 1920. In all other countries, except France, population increased between 1910 and 1920 despite the devastations of war. (Graph from Thirteenth U. S. Census, Vol. I, page 35, with curves extended to include post-war data.)

in the ancient Roman Empire? Or will recurring wars keep the population comfortably within the limits set by our agricultural resources?

These are questions that no one can answer, but they clearly indicate that the time is at hand when the leaders of the white race should take stock of the agricultural resources of the lands they hold and of the trend of population, and decide upon both a land policy and a population policy, lest the poverty, disease, and political disintegration that characterizes many of the overpopulated and undercapitalized countries of the Orient come upon us also.

The purpose of this paper is to encourage the making of such a survey of agricultural resources. The estimates that are given are only tentative, indeed, most of them can be little more than guesses.

## WHEAT THE WHITE MAN'S FOOD

Wheat, supplemented in certain European countries by rye, contributes from one-quarter to one-half of the fuel value of the food eaten by the white peoples of the world (Fig. 3). Just as rice characterizes the diet of the yellow race, and corn or manioc is the usual fare of the black race, so wheat may justly be called the white man's food. The cause, no doubt, is partly traditional, partly climatic, since the white people hold the lands having the best wheat climates, but it is also partly economic.

Wheat is the most expensive of the great cereals, except rice.[1] The white man is rich, at least in the United States,

[1] The average price of wheat per 100 pounds during the past four years (1920–1923) on the Liverpool market, which is one of the world's greatest grain markets, was about $2.75; as compared with $2.25 for oats, $2.00 for rye and corn, and $1.80 for barley. For rice the average price at Liverpool during the four years was $3.88, and at Shanghai, as well as New York, the price of rice per pound in nearly every month during recent years has been more than double the price of wheat. Why the poverty stricken peoples of the Orient eat rice is a problem that cannot be explained here.

The higher price of wheat is owing in part to its lower yield per acre. For the United States during the past ten years (1914–1923) the average acre yield of wheat has been 819 pounds; of rye, 813 pounds; of oats, 1020 pounds; of rice, 1066 pounds (cleaned); of barley, 1197 pounds; and of corn 1564 pounds. This higher price of wheat is also due in part to its greater palatibility and higher gluten content. Because gluten releases very slowly the gases formed by the fermentation of the yeast, wheat can be made into a more porous bread than does flour from any other grain. Wherever people can afford it, they usually prefer this lighter wheat bread. This is as true of the negroes in the United States who have recently obtained higher wages, as it is of the peasants of southeastern Europe, who, after the recent confiscation of the large estates, consumed most of the wheat that had formerly been available for export.

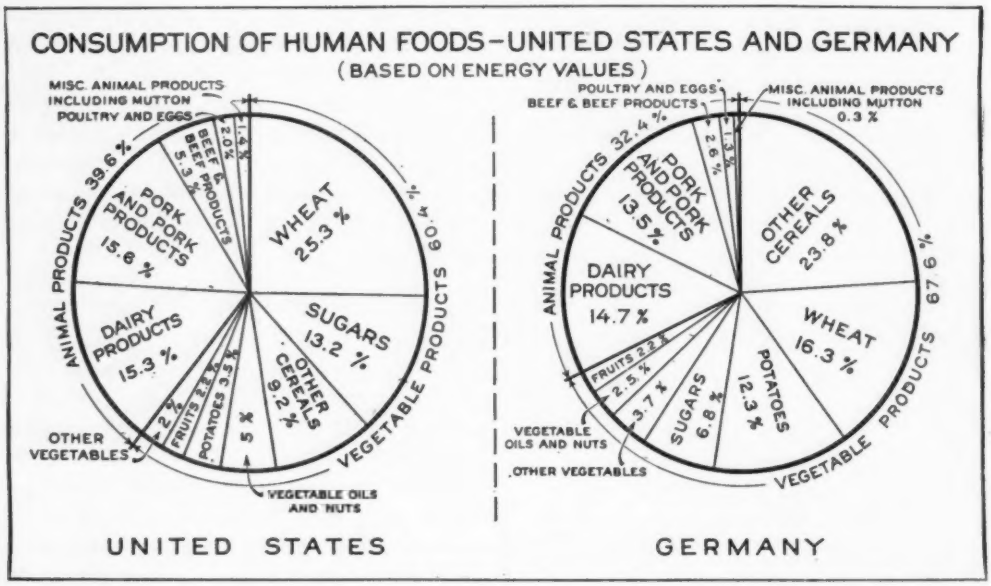



FIGURE 3.—Wheat contributes 25 per cent of the sustenance of the people of the United States, as measured in calories, and other cereals nearly 10 per cent more. In Germany before the war wheat constituted only 16 per cent of the total sustenance, but rye and other grains brought the total up to 40 per cent. The importance of sugar in the United States and of potatoes in Germany should be noted. The German diet was quite adequate, and yet it involved only 85 per cent as much crop land per capita as the American diet, and only 65 per cent as much pasture, United States acre yields being assumed for both countries. (Graph from 1923 Yearbook of U. S. Dept. of Agriculture.)

the British Commonwealth, and much of western Europe, whereas the other peoples of the world are poor. Although the white race possesses 70 per cent of the cultivated land of the world, and even a larger proportion of the land suitable for wheat, it comprises only 40 per cent of the world's population. In other words, the white race possesses over three times as much cultivated land per person as the other races of the world, and probably four times the per capita area of land suitable for wheat. Moreover, the white race possesses most of the coal, the iron, and the mineral oil of the world, of which the products can be exchanged for wheat when needed.

Yet nearly one-third of the white race cannot afford wheat bread except on festive occasions. For about 150,000,000 people of northeastern Europe rye is the staff of life, and nearly 50,000,000 more in Mediterranean countries and southeastern Europe depend largely on corn for their sustenance. It is only the more prosperous of the white race,—the Anglo-Saxon peoples, the French, some of the Italians, Hungarians and Roumanians, and the more fortunate of the Teutons and Slavs, who enjoy without stint the luxury of the wheaten loaf.

### THE TREND OF POPULATION OF THE PRINCIPAL WHEAT-EATING PEOPLES

The problem reduces itself, therefore, to determining whether wheat can be provided in the future for these more fortunate portions of the white race, or whether they too will be forced gradually to rely on corn, barley, rice, and other crops that produce more food per acre. The first step, obviously, is to estimate the numbers of the Anglo-Saxon, French, Italian, Hungarian, Roumanian, Teutonic, and Slav peoples twenty-five, fifty, and one hundred years hence. This is a task for the demographer rather than the geographer, but since the former has failed to do it, the

geographer must venture upon the very slippery path of population prediction.

The population of the Anglo-Saxon nations, including the United States, is increasing at present at the rate of about 1.3 per cent a year (Fig. 4). It appears, however, that as population increases, the rate decreases. The increase is approximately stationary at about 2,100,000 a year, two-thirds in the United States, one-third in the British Empire. The Anglo-Saxon nations, therefore, may be estimated to have 225,000,000 white people twenty-five years hence, possibly 275,000,000 fifty years from now, and, perhaps, 375,000,000 a century hence, as compared with the 175 millions of today.

The population of France is stationary at about 40,000,000. That of Italy was increasing before the War about 200,000 a year, which would indicate an increase from the 40,000,000 at present to possibly, 60,000,000 a century hence. Hungary and Roumania include nearly 26,000,000 people, and are increasing over one per cent a year. These countries may number 60,000,000 people a hundred years hence.

In Germany, the population, except during the war years, has been increasing about 800,000 a year, in the Scandinavian countries nearly 100,000 yearly. Austria, the Netherlands, and German Switzerland are increasing fully 100,000 yearly. The increase in population of the Teutonic peoples, therefore, may be estimated roughly at a million annually. As there are now about 100,000,000 Teutons in Europe, this rate of increase would indicate 125,000,000 twenty-five years hence, 150,000,000 in fifty years, and 200,000,000 after a century. But as over sixty per cent of these Teutonic peoples live on rye rather than wheat, we need include in our estimate of wheat-eating peoples a century hence only 80,000,000 Teutons.

The statistics of population of the Slavic and adjacent peoples are less trustworthy, but according to official figures the population of the Russian Empire increased from 74,000,000 in 1859 to 129,000,000 in 1897, and to 178,000,000 in 1914. This increase of 50,000,000 people, or about 40 per cent, in the seventeen years from 1897 to 1914 is no greater in rate than that during the early decades of our own national development; but it is very unlikely, after the scars of war are healed and the present economic experiments are completed, that population in both European and Asiatic Russia can continue to increase at any such rate for a century. So little is known of the situation in Russia that prediction of the future

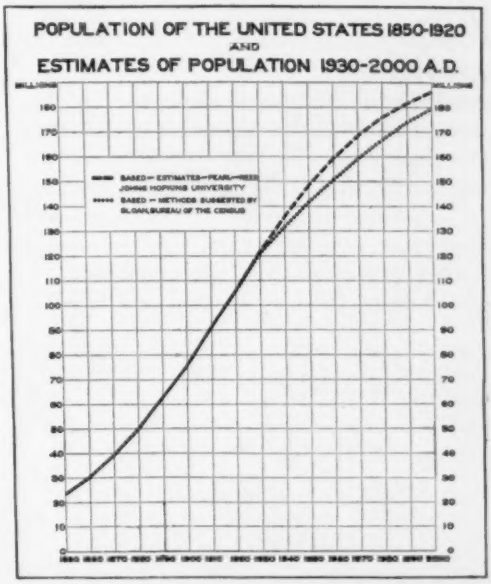



FIGURE 4.—From the Revolutionary War to the Civil War the increase of population was at the almost uniform rate of 35 per cent each decade; from 1870 to 1880 population increased 30 per cent; from 1880 to 1890, 25 per cent; from 1890 to 1910, 20 per cent; and from 1910 to 1920, 15 per cent. Should even this low rate of increase during the past decade, which included the World War and several epidemics of influenza and also six years without immigration, continue, our country would have in about a century a population equal to that of China today.

But according to estimates of Dr. Pearl and Dr. Reed, of Johns Hopkins University, made on the basis of certain mathematical and biological deductions, this rate of increase will not continue but will gradually diminish so that by 1950 our population will be only about 150 millions, and by the end of the twentieth century will reach an almost stationary state, like that of France today, at 185 to 190 millions. (Graph from article by the author in Geographical Review, Jan. 1923.)

population becomes difficult, if not impossible; but let us assume, as a basis for discussion, that it will increase in the next century as much as it has in the past century, or about 135,000,000. A century hence the population of Russia, the Baltic States, the portion of Poland formerly part of Russia, and Bessarabia may be estimated, therefore, at about 300,000,000; but since about half of these Slavic peoples now live on rye rather than wheat, for the purpose of this discussion we should include in our wheat-eating Slavic peoples a century hence only 150,000,000.

This leads to a very rough estimate that the number of that portion of the white race accustomed to eating wheat will increase from 400,000,000 at present to about 500,000,000 twenty-five years hence, 600,000,000 in fifty years, and 800,000,000 after a century. Nearly half

FIGURE 5.—This picture shows two kinds of wheat, one bearded and the other beardless. Some wheats are spring sown, others fall sown. There are bearded and beardless varieties of both types. The wheat plant grows usually from two to five feet high, but in arid regions or seasons it may be still shorter and sometimes hardly tall enough to harvest. The kernels are carried in heads at the top of the plant and are enclosed by chaff or glumes. When the plant turns yellow and the kernels become hard, the crop is ripe. Wheat is cut near the ground in humid areas by a reaper or binder (see Fig. 25), or by a scythe or sickle, as in parts of Europe and Asia (see Fig. 29). The cut wheat, which usually is bound into sheaves, is cured in shocks, or stacks. The grain is separated from the chaff and straw by threshing.

In some areas having sub-humid or semi-arid climates as in our western states, Argentina, and Australia, only the heads are harvested and the straw left standing on the ground (Fig. 26). Three types of machines are used. The header most commonly used in America cuts off the heads, while the stripper in Argentina and Australia pulls them off. The heads may be threshed immediately or stacked and threshed later. In these same dry areas a combined harvester-thresher or "combine" may be used (Fig. 27). This heads, threshes, and sacks the grain as it moves across the field. After threshing by any kind of machine the grain may be put in sacks or delivered in bulk directly into wagons. It then may be stored in farm granaries or hauled immediately to the elevator or warehouse (Fig. 34). (Photo by Bureau of Plant Industry, U. S. Dept. of Agriculture.)

of this population will live in the Anglo-Saxon countries.

### THE FUTURE NEED FOR WHEAT

The per capita consumption of wheat among the wheat-eating countries varies considerably. Bread probably contributes a smaller proportion of the diet in the United States and Great Britain than in any other important country inhabited by the white race. Widespread prosperity has permitted the partial substitution of a multitude of other foods. The annual per capita consumption of wheat, excluding seed and exports and including imports, for the pre-war period, 1909–1913, was about 5.8 bushels in the United States and also in Great Britain, 6.4 bushels in Italy, 8.4 bushels in France, 3.33 bushels in Germany, to which may be added 6.7 bushels of rye, and 3.1 bushels in Russia, to which may be added 5.5 bushels of rye.

If the per capita consumption of wheat, excluding seed, among these peoples remains the same as today, the Anglo-Saxon nations will need 1,300 million bushels of wheat twenty-five years hence, 1,600 million bushels fifty years hence, and 2,200 million bushels after a century, as compared with 1,000 million bushels today. The other wheat-eating peoples mentioned will need 1,900 million bushels, excluding seed, twenty-five years hence, 2,275 million fifty years hence, and 3,025 millions after a century, as compared with 1,525 million bushels today. The total requirement of these people, after allowance is made for seed, will be 4,300 million bushels fifty years hence, and 5,800 million bushels 100 years hence.

If the average per capita consumption of the Anglo-Saxon and the other white wheat-eating peoples should increase to that of France today, which is very likely as the consumption of more expensive food declines, the total requirement of these people, including seed, will become 5,500 million bushels fifty years hence, and 7,400 million bushels one hundred years hence. Can the white man's world almost treble its production of wheat within a century, or even produce the 5,500 million bushels which it appears may be needed within the lifetime of some of us? If so, from where and how? These questions involve consideration of the physical and economic conditions which affect the production of wheat.

## THE PHYSICAL CONDITIONS

The physical conditions which affect the production of wheat, and of all other crops, may be classified into four groups:

1. Temperature conditions, particularly growing season temperatures and dates of occurrence of spring and fall frosts.
2. Moisture conditions; *i.e.*, rainfall, snowfall, hail, fog, humidity, rate of evaporation.
3. Topography, or land form; *i.e.*, the configuration of the earth's surface, degree and direction of slope, roughness or smoothness of the land.
4. Soils, including both physical structure and chemical and bacteriological characteristics.

In general, climatic similarity characterizes much broader areas and the transition from one type of climate to another is less abrupt than is the case with the types of soil and land surface. Temperature conditions are peculiarly pervasive and practically unalterable. They set the outer limits to crop production. Whether a crop is grown within these temperature limits depends upon the moisture, the topography (land surface), and the soils, and also upon the economic situation. These physical conditions will, therefore, be taken up in succession and their effect noted in reducing the area available for wheat production.

### TEMPERATURE REQUIREMENTS

The cold limit of wheat production, that is, the northern limit in the northern hemisphere, the southern limit in the

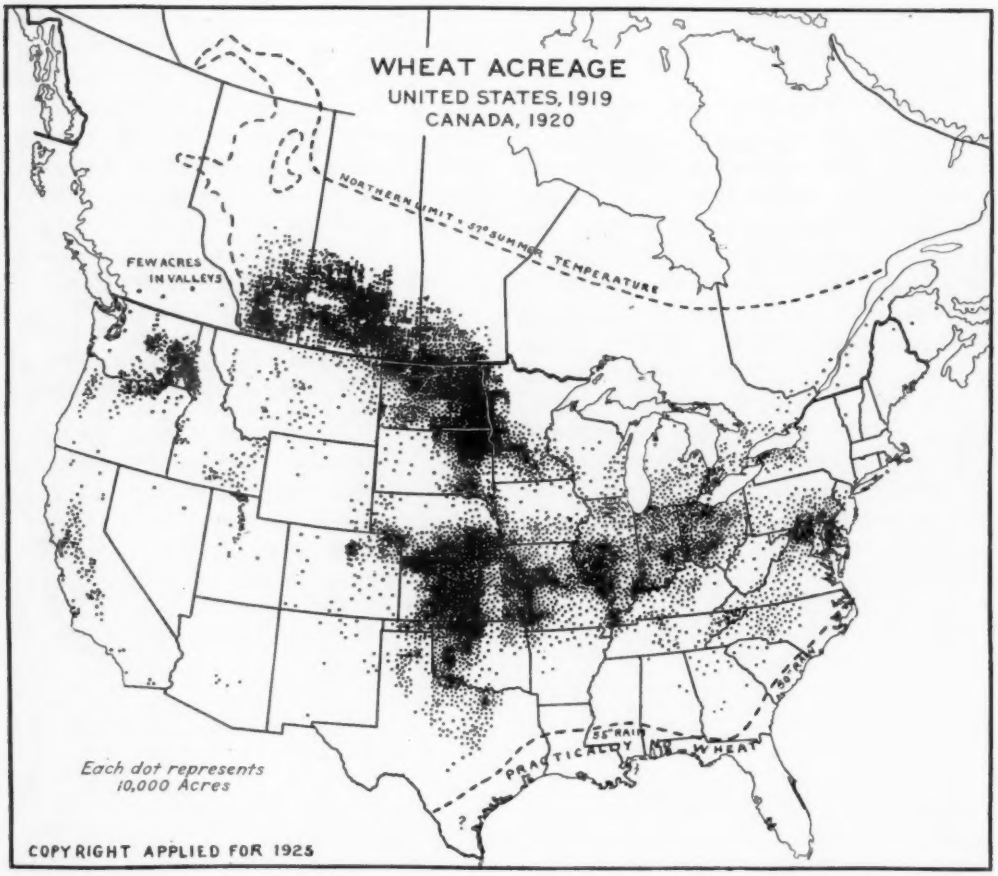



FIGURE 6.—In 1919 over 73 million acres of wheat were harvested in the United States, and over 18 million in Canada. It was a very dry season in the northwest and millions of acres were not worth harvesting, so that probably almost 100 million acres were planted in the two countries. This is about one-ninth of the area physically available for wheat. Other crops, of course, are raised on land suitable for wheat, but the area of potential wheat land used at present for pasture and forest is even greater than that used for other crops.

In Canada there is a vast area available between the present northern margin of wheat acreage, which is primarily economic, and the physical limit of production, which is approximately the line of 57 degrees average summer temperature. In the United States there is even a greater extent of forest land in the South and in the North, as well as grazing land in the West, which can be used for wheat when a higher price justifies the cost of clearing and fertilization, or, within the semi-arid regions, compensates for the low yields.

As population increases, the acreage of crop land will increase at the expense of pasture and forest land. At present nearly all the increase in crop acreage is at the expense of pasture, notably in the Great Plains region. Wheat contributed over half of the 45 million acres increase of crop land in the United States between 1909 and 1919, and also over half of the 17 million acres increase in Canada between 1910 and 1920. The enormous increase in wheat acreage during the war years at the expense of pasture and other crops indicates what is likely to recur when population becomes denser.

southern hemisphere, and the upper limit in regions of high altitude, is approximately the average temperature of 57° during the three warmest months, (June, July, and August) in North America and Europe, and about 58° in Asia, where the seasonal rise and fall in temperature is more rapid. Severe frost should not occur during the latter two months of the period. In addition to certain hay crops (which need not ripen seed to be fit for harvest), only barley and potatoes are grown under colder conditions than wheat.

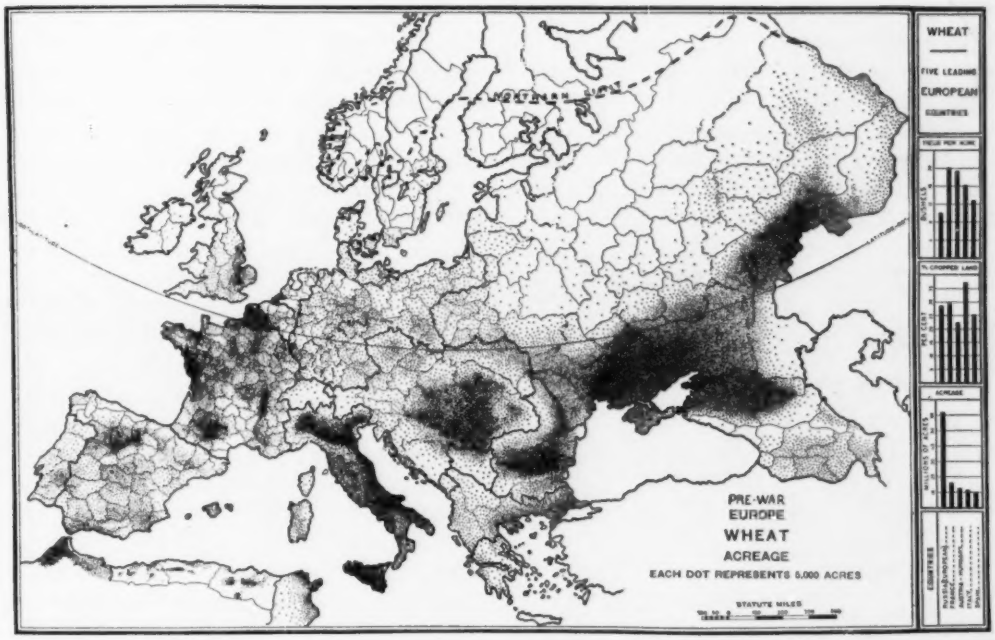



FIGURE 7.—Wheat is the most important crop in Europe. Prior to the War about half the acreage, but less than one-third of the production, was in Russia (including Russian Poland and Bessarabia). The average acre yield for Russia for 1909–13 was 10.6 bushels, whereas for the remainder of Europe it was over 22 bushels. In Scotland, Denmark, Netherlands, and Belgium the average acre yield is nearly 40 bushels. Consequently the map above must not be used to compare the density of production of wheat in different portions of Europe, for the production per square mile is about double as great in northern France, northern Italy, and the Hungarian Plain as in any part of Russia. (Map adapted from "Geography of the World's Agriculture," U. S. Dept. of Agriculture, 1917.)

The northernmost point of wheat production in North America is found at Ft. Yukon (latitude 66°–20′), Alaska, on the Arctic Circle about one hundred miles west of the Canadian boundary. Wheat has been grown at a few points along the Yukon river southwestwardly from that place almost to its mouth. The Alaskan coast is too cool in summer for the successful production of wheat. In all Alaska it has been estimated that there may be 40,000 square miles, or 25,000,000 acres potentially available for grain production. Practically all this land is contained in the valleys of the Yukon, Kuskokwim, Tanana, Susitna, and Copper rivers. Undoubtedly, never more than one-tenth will ever be seeded to wheat. This would be an acreage equal to that in Ohio or Washington at present.

Wheat is not grown successfully in the Mackenzie Basin of Canada north of Fort Simpson, which lies at latitude 62° N. and is nearly 800 miles southeast of Fort Yukon. From Fort Simpson the northern boundary of possible wheat production continues southeast across Canada for 1,600 miles, practically following the isotherm of 57° summer temperature, till a point eighty miles south of James Bay is reached, whence the line runs almost directly east for 600 miles following latitude 50° to the Gulf of St. Lawrence (Fig. 6). The southerly descent from the Arctic Circle to latitude 50°, or nearly 1,200 miles, in a total distance of about 3,000 miles, indicates how much warmer interior Alaska is in summer than its latitude would indicate. In northern Canada and Alaska there are about 3,400,000 square miles too cold for the production of wheat.

The trend of the northern limit of wheat production across Europe and Asia is similar to its trend in North America (Fig. 7). No wheat is grown along

the cool northwest coast of Scotland, where the summer temperature is below 57°. In northern Norway back from the coast along the fiord inlets a little wheat is grown as far north as latitude 68° 50′, but commercial production begins near the southwest corner of Norway, whence the boundary trends northeast across Sweden, to Sundsvall on the Gulf of Bothnia at latitude 62°–25′.[2] On the Finnish side of this Gulf a very small acreage is also found. The northern limit then trends southeast across Finland and northern Russia to about latitude 62° on the railway between Vologda and Archangel. Then the line seems to run almost due east for 500 miles before it swings south in crossing the Ural Mountains.

In Siberia wheat is grown along the Irtysh river almost to its junction with the Ob near Samaroysk at latitude 61° (Fig. 8). Nansen reports the first grain farming as he travelled up the Yeniseisk river at latitude 61°, and some 65,000 bushels were officially reported as harvested in the Lena valley near Yakutsk, at latitude 62°, for the seasons of 1911

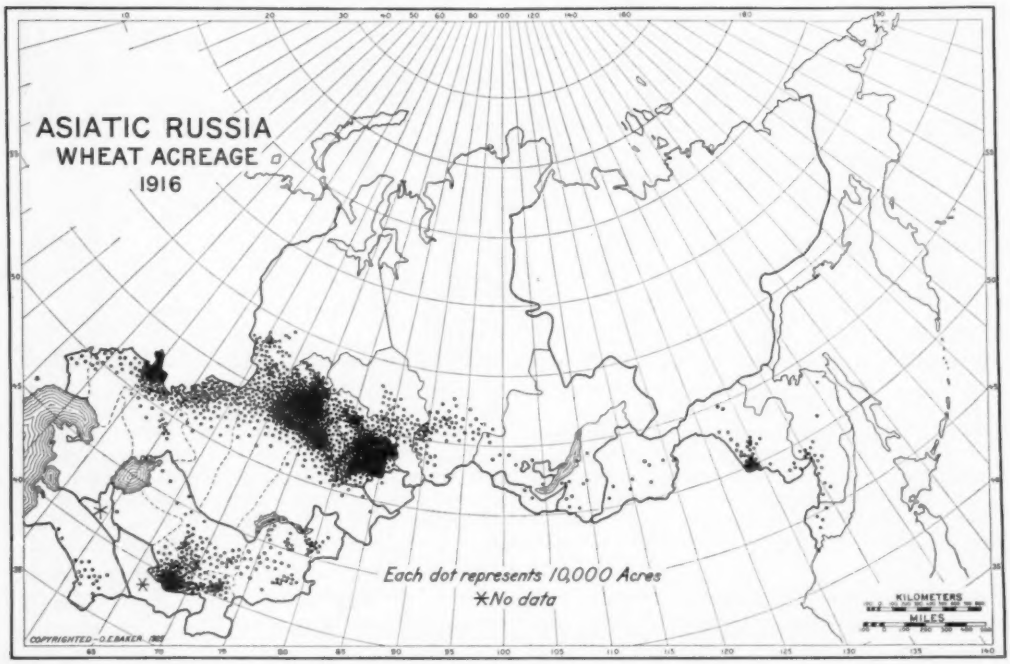



FIGURE 8.—Nearly 18 million acres were in wheat in Asiatic Russia in 1916, and the yield was about 185 million bushels. Most of this wheat was produced in western Siberia in the belt of black soils which extends from European Russia about half way across southern Siberia. The acreage is densest in southern Tobolsk (Tumène), Omsk, and Tomsk, and in northern Uralsk, Turgai, Akmolinsk Semipalatinsk, and Altai. South of this wheat belt lies the desert and semi-desert of Turkestan. Over half of the wheat shown in Turkestan is grown under irrigation. The acreage in Turkestan is for the year 1917. Wheat production in Asiatic Russia in 1922 and 1923 was between a third and a half as great as in 1916. (Territorial boundary lines are for 1922, and are from a map supplied by Robert Kelley, Department of State, dots located by Sophia Saucerman. Copyrighted by O. E. Baker, 1925.)

[2] Two acres of wheat are reported for 1923 at Trondenes (68°–50′ N.; 16°–40′ E.) in Troms (fylke). This is the northernmost wheat field in the world. Only five acres, however, were grown north of the Trondjem district (63°–30′ N.). In this Trondjem district 200 acres were grown. The average summer temperature at Trondjem is only 56°. A few acres of wheat are grown at Boden, Sweden, latitude 66°, near the north end of the Gulf of Bothnia. Only 38 acres are reported in the census for Sweden north of the lons of Vöster, in which Sundsvall is situated.

and 1912.[3] The Vitim Plateau between Lake Baikal and the Amur Basin is mostly too high and cold for wheat. Along the cold Pacific coast of Siberia only a little wheat is grown north of Nikolayevsk at latitude 54°.[4] In Siberia and northern Europe there are about 4,500,000 square miles too cold for the production of wheat.

The cold limit of wheat production in Argentina and Chile is found at a much lower latitude than in North America and Eurasia. There is no wheat reported in the census of either country in districts south of latitude 45° and very little south of latitude 42°. Apparently, the cool ocean waters reduce the summer temperature in the southern tip of South America below the amount required to mature wheat. The Argentine portion, moreover, is very dry, and the Chile portion very wet (Fig. 9). In this far southern section of South America there are, perhaps, 125,000 square miles too cool for the production of wheat.

Between the northern limit of wheat production in North America and Eurasia and the southern limit in South America lie about 44,000,000 of the 52,000,000 square miles of land area of the earth not in polar regions perennially covered with ice, and after deducting 3,000,000 acres for highlands too cold for wheat (mostly the Thibetan and Andean Plateaus), 41,000,000 acres, or about 80 per cent of the land surface of the earth (excluding polar continents and islands), remain sufficiently warm for the production of wheat.

No part of the earth is too hot for the production of wheat if the climate is not humid. Wheat is an important crop in some of the hottest regions of the world, for example, in the Punjab of India, in Mesopotamia, and in southern Arizona. It is the humidity of the tropics which restricts wheat very largely to the temperate zones. The rusts, smuts, and other diseases of wheat which flourish in a moist, warm atmosphere, are almost as destructive in a cool, moist atmosphere, indicating that the primary limitation in the tropics is imposed by moisture conditions.

FIGURE 9.—The wheat region in Argentina and Uruguay is limited on the northeast by increasing humidity and on the west and southwest by increasing aridity. Between these two boundaries there are, apparently, 400,000 square miles of land physically available for wheat production. But wheat shows almost no tendency as yet to expand into the warmer northern portion of this zone of moderate rainfall, and there may be other limiting factors which, if known, would greatly reduce the estimate. The narrow belt of wheat production in Chile should be noted, bounded on the east by the Andes mountains, which are both too cold and too rough, on the north by the desert, on the south by a very humid climate and heavy forests, and on the west by the sea. (Map adapted from "Geography of World Agriculture," U. S. Dept. of Agriculture, 1917.)

[3] The average area in wheat in the Province of Yakutsk for the three years 1911, 1912 and 1920 is 5,332 acres.

[4] In the Atlas of Asiatic Russia (Plate No. 50, extent of wheat production) the northern limit is shown near Ayan, but the statistical reports give practically no wheat north of Nikolayevsk.

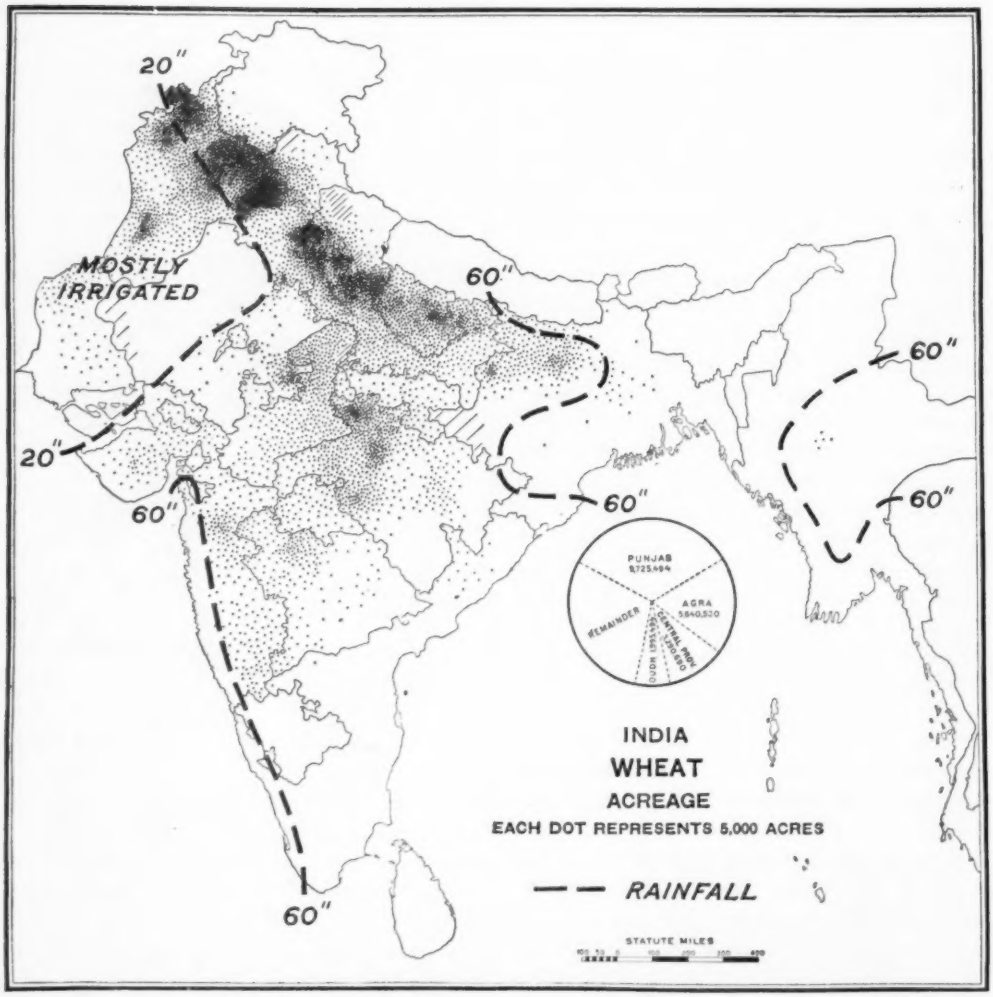



FIGURE 10.—In India, as in other parts of the world, wheat production is densest in regions of subhumid climate. Most of the wheat, excluding that irrigated, is grown in regions having between 20 and 60 inches annual rainfall. In the humid eastern and southeastern portions, rice, which produces more food per acre, replaces wheat. The acreage of rice in India is two and one-half times that of wheat and the production nearly three and one-half times as much. Owing to the dense population and extreme poverty, the people lack the capital required to purchase fertilizer, and they burn the manure for fuel. Consequently, there seems little likelihood of a material increase in yield of wheat per acre. And as labor is cheap and land is costly, wheat cannot expand in acreage at the expense of the more productive rice and cotton crops. There seems to be the possibility, however, of a small increase in wheat acreage at the expense of less productive crops, and by extension of irrigation. (Map adapted from "Geography of World Agriculture.")

### MOISTURE REQUIREMENTS

Wheat has both humid and arid limits. The humid limit varies with temperature. In the southeastern United States, where the average temperature during the two months preceding harvest exceeds 68°, very little wheat is grown in those sections having an average annual rainfall exceeding fifty inches; but in the northeastern United States, where the temperature during these months is a few degrees cooler, forty inches annual precipitation practically marks the humid boundary of wheat production. Likewise in England, Scotland and Ireland, the humid limit of commercial

wheat production appears to be about forty inches, and most of the wheat is grown where the annual rainfall averages less than thirty inches. A wet season in England is unfavorable to wheat, and a dry season is favorable. In the moister portion of India the temperature during the two months prior to harvest appears to be no higher than in the southeastern United States, but the humid limit of wheat production seems to extend to the zone of sixty-five to seventy inches annual rainfall (Fig. 10). It would appear, therefore, that near the cold limit of wheat production forty inches annual precipitation approximately marks the humid limit, while in India, where the temperature during the two months prior to harvest is about five degrees warmer, seventy inches is the upper limit. This increase of six inches annual rainfall for each degree increase in temperature is somewhat greater than that along the humid boundary of the crop in the eastern United States.

The arid limit of wheat production likewise varies with temperature. Wheat is grown in central Washington on a lower annual rainfall than elsewhere in the United States. The arid limit there is about nine inches average annual precipitation, but the rains occur mostly in winter and spring when the evaporation is small. The moisture of one season is conserved in the soil by summer fallowing, and thus much of the rainfall of two seasons is combined for a crop the second season. In central Alberta, Canada, where annual crops of wheat are grown, about eleven inches precipitation, received mostly in spring and summer, marks the arid limit of production; whereas in west central Texas, where the summer temperature is 20° higher and the evaporation much greater, but much the same seasonal distribution of rainfall prevails, about nineteen inches annual precipitation corresponds with the arid limit of production. Apparently, the arid limit of wheat production in northwest India is found at about the line of twenty inches annual rainfall.

Thus, it would appear that the production of wheat near its cold limits is confined to regions receiving on the average between 10 and 40 inches of rain (and equivalent in snow) annually; whereas in the hottest portions of the world, these boundaries become 20 and 70 inches. In certain intermediate regions, such as the west-central and southeastern portions of the United States, the lower limit is 15 to 17 inches, and the upper limit 50 to 52 inches.

Proceeding in such fashion on the basis of available climatic data, checked by statistics of wheat production, the conclusion is reached that about seventeen millions of the forty-one million square miles of the land of the world having sufficient warmth for the production of wheat are too dry, and about thirteen million square miles are too wet, to grow wheat successfully. Thus, considering both temperature and moisture conditions, only about eleven million square miles remain climatically suited to wheat production. The principal areas too dry for wheat are Mongolia and southwestern Asia, nearly all of northern Africa and much of southwestern Africa, most of Australia, and of southwestern Argentina, portions of Chile and Peru, most of Mexico and of the southwestern third of the United States,—in all nearly one-third of the land surface of the world outside the polar continents. The principal areas too wet for wheat are the Amazon and the Congo basins, eastern India, Indo-China and southern China, the East Indies, much of the east and southeast coasts of Australia and the United States, and of the northwest coasts of North America and Europe,—in all about one-fourth of the non-polar land of the world.

### LAND RELIEF OR TOPOGRAPHY

Some of the land of the world climatically available for wheat production, particularly in the temperate zones, is too hilly, steep, or rough to be cultivated successfully. Slopes of more than fifteen feet to one hundred feet horizontal

distance are seldom used for wheat production in the temperate zones, but in tropic lands steep hillsides are sometimes cultivated by hand, since these rapidly eroding soils are unleached and fertile.

The topographic limits are less definite, and more localized, than the climatic limits. Moreover, largely because of the local variations in land relief, much less is known concerning the area of land of different degrees of slope, or roughness, than is known about climatic conditions. Consequently, estimates of the extent of land too hilly or rough for wheat cultivation become, outside the United States and a few European countries, merely more or less intelligent guesses.

In the United States, within the regions that are climatically available for wheat production, nearly 300,000 square miles are too hilly or rough for the cultivation of wheat, or about 22 per cent of the climatically available area.[5] In western Europe, excluding Scandinavia and Scotland, nearly all the land is climatically available for wheat, except the higher altitudes in the Carpathians, Alps, and Pyrenees, but over 50 per cent of the total area is classified as non-arable land. As about 15 per cent of the land in western Europe is sandy, peaty, or otherwise unsuitable for wheat, but in part suitable for rye and other crops, apparently 35 per cent of the climatically available land is too hilly or rough for wheat production. European Russia and western Siberia, however, are much like the central United States in land relief, indeed, probably not over 20 per cent of the land is too hilly or rough for the production of crops. Eastern Siberia is more mountainous and broken than western Europe, and of the small area having sufficient warmth for wheat production, probably 40 per cent is topographically unsuitable for cultivation. This percentage is probably not far wrong for China, also.

Proceeding by such comparisons, and using also estimates of cultivated land and productive land for some thirty-eight countries compiled by the International Institute of Agriculture, the conclusion is reached that nearly four million acres of land in the world climatically available for wheat are unfit for use because of hilly or rough land surface. Subtracting these four million square miles from the eleven million square miles climatically suitable for wheat leaves seven million square miles climatically and topographically available for wheat production.

### SOIL REQUIREMENTS

Wheat is not grown successfully on sandy, gravelly or peaty soils, nor on heavy clay in cool climates. In warm climates clay soils take on a more permeable character and are often used for wheat. In the United States, thanks to the work of the Soil Survey, it is possible to estimate fairly closely the area of these kinds of soils, but in other countries very little information exists. Within the areas climatically and topographically suitable for wheat in the United States, about 120,000 square miles, or 11 per cent of the land otherwise available, does not possess soils suitable for this crop.[6] In Canada, although wheat can be grown successfully on sandier soil than farther south, the extent of sandy and gravelly soil is relatively greater than in the United States, and the extent of stony land and bare rock is much greater. There is also a vast area of peat land. In all, the extent of land possessing unfavorable soil conditions but otherwise available for wheat in Canada probably exceeds 20 per cent and may amount to 30 per cent within the area climatically and topographically suitable.

In the portions of Europe, climatically

[5] Based on an estimate for 27 states prepared by F. J. Marschner, of the U. S. Dept. of Agriculture, from county soil survey reports, topographic maps, census data, and similar sources.

[6] Estimate prepared by Mr. F. J. Marschner, of U. S. Dept. of Agriculture, primarily on basis of soil survey reports.

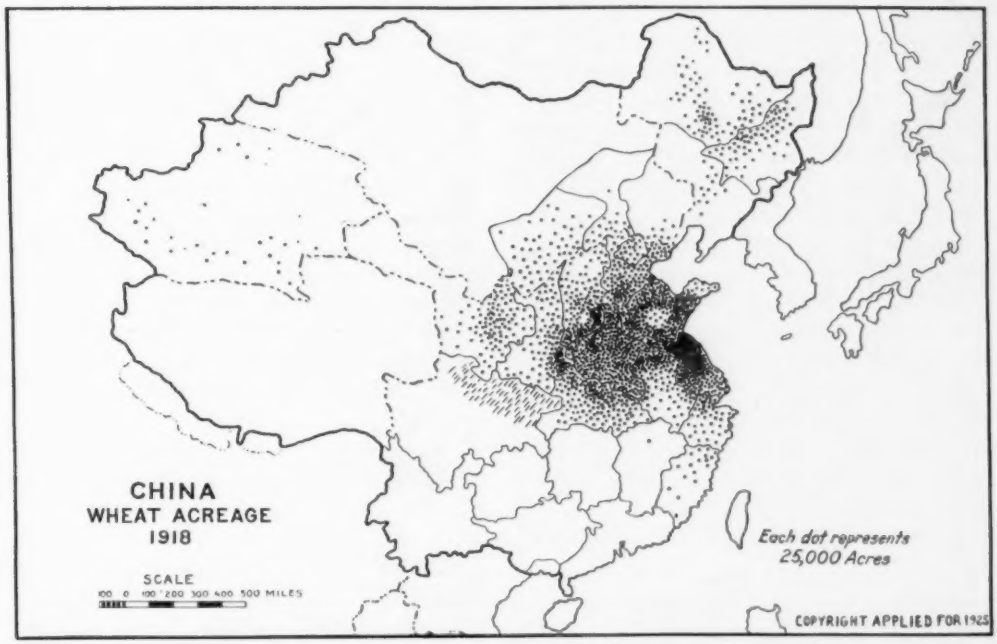



FIGURE 11.—The area of wheat in China, according to the 1918 report of the Chinese Department of Commerce and Agriculture, is about 300 million mou, or 50 million acres (after correction is made for the obvious typographical error for Honan). This is almost as large an acreage as in the United States, but as a large part of the wheat is planted in rows alternating with other crops, the quantity of wheat produced is probably smaller than in the United States. The wheat is grown mostly north of the Yangtze river, southeastern China having too humid a climate for profitable wheat production. The shading in Szechwan represents the area in which wheat is grown, judging from data for adjacent provinces. The figures for this province are not available. (Translation by H. Huang, of Chinese Legation, data located by Margaret Hitch on basis of China Continuation Committee's report. (Copyrighted by O. E. Baker, 1925.)

and topographically adapted to wheat, the proportion of sandy, gravelly and peaty soil is probably about 20 per cent, which is less than in Canada but greater than in the United States. In tropical and subtropical countries owing to the leaching of the soil and common occurrence of hardpan, probably nearly a fourth of the land otherwise available for wheat is unsuitable because of soil conditions.

Proceeding in this way by comparison, and on the basis of the meagre knowledge of soil conditions in the various countries, we reach the conclusion that of the seven million square miles climatically and topographically available for wheat, about one and a half million square miles possess unsuitable soils. This leaves about five and a half million square miles of land in the world physically available for wheat production.

## LAND PHYSICALLY AVAILABLE FOR WHEAT

The distribution of this potential wheat land is significant. About 1,400,000 square miles are in North America, of which 1,000,000 are in the United States and 400,000 in Canada. Possibly 500,000 square miles are in South America, fully four-fifths of which are in Argentina. About 1,500,000 square miles are in Europe, of which fully half are in Russia, and nearly half in the rest of Europe. It will be noted that the area physically available for wheat in the United States and Canada is almost equal to that in Europe. Probably 500,000 square miles more are found in Asiatic Russia, which is a quarter greater than the area available in Canada. In other words, the Russian Empire has a considerably greater area physically

available for wheat than the United States, and almost as great as that of the United States and Canada combined. China, including Manchuria, has, perhaps, four hundred thousand square miles available for wheat (Fig. 11), and India about the same amount. In all Asia almost certainly not over 1,500,000 square miles are available for wheat production, or no more than in Europe.

In Africa perhaps five hundred thousand square miles are physically available for wheat, according to an estimate prepared for the writer by Dr. H. L. Shantz, of the U. S. Department of Agriculture, on the basis of his map of natural vegetation. Half of this amount is in the highlands of Central Africa and Ethiopia, one-fourth along the northern and southern margins of the Sahara desert, and the remaining fourth in South Africa. Australia and New Zealand have about 150,000 square miles of present and potential wheat land. Wheat production in Australia is practically confined to a narrow belt of land between the lines of ten and twenty inches rainfall during the season April to October (Fig. 12).

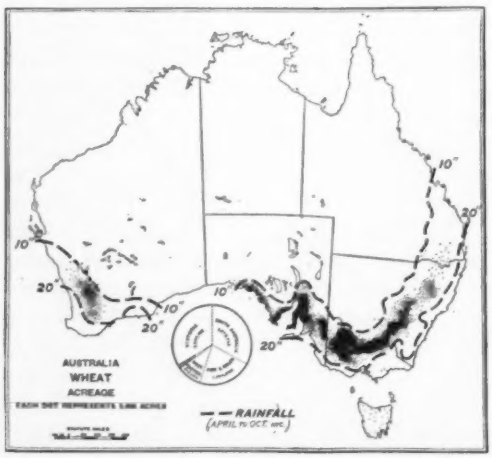



FIGURE 12.—The wheat crop in Australia is grown mostly along the southeastern and southwestern margins of the great interior desert, in a zone where the rainfall during the growing season, April to October, is not less than 10 nor much over 20 inches. In the moister coastal belt other crops and dairying are more profitable than wheat. (Map adapted from "Geography of World Agriculture.")

Over half of the land in the world physically available for wheat apparently, is in the Eurasian continent, the original home of the wheat plant. Wheat was first cultivated in western Asia, probably in Palestine or Syria, and a circle drawn with the center in Palestine and having a radius of 3000 miles will include all the physically available wheat land of Europe, most of that in Siberia and India, all the wheat land in northern Africa and nearly all that in central Africa, a total of 2,700,000 square miles, or about half the land available for wheat in the entire world.[7]

Not over 500,000 square miles, or about one acre in 100 of the land area of the earth, is in wheat at present (Fig. 13). In other words, less than one-tenth of the land in the world physically available is used to produce wheat. Why is this proportion so small? Two reasons are obvious. First, man cannot live by bread alone; he must grow other crops and perhaps use a part of the land for pasture or forest. Second, the need of some of the peoples of the world for wheat is not yet sufficiently great to justify a larger acreage, and with other peoples the population is so dense that more productive crops must be grown. These reasons require a brief consideration of the competition between the various crops for the use of land, and also of the competition of pasture and forest with crops for the land. To understand this competition requires mention of some of the more important economic principles which affect the geography of production.

[7] The ancestor of the wheat plant, it is believed, was discovered in northern Palestine in 1906 by Aaron Aronson, of the Jewish Agricultural Experiment Station at Haifa (see U. S. Department of Agriculture, B. P. I. Bulletin No. 180). The plant resembles emmer in appearance, grows mostly in the crevices of limestone rock, and could at best yield only a bushel or two of grain per acre. Although the winters in Palestine, as in all the countries bordering the Mediterranean, are moderately moist, the summers are very dry and the climate of the region may be characterized as sub-humid. The wheat plant persists in retaining a preference for such sub-humid climates and for soils rich in lime.

## THE ECONOMIC PRINCIPLES

Six economic principles help in understanding why wheat in different parts of the world occupies a varying proportion of the land.

1. The crop or other agricultural product which is most limited in climatic or other physical requirements of production will, if the demand for it be sufficient, have first choice of the land. It possesses, so to speak, a sort of natural monopoly and consequently commands a price which gives it an advantage over other crops or products.

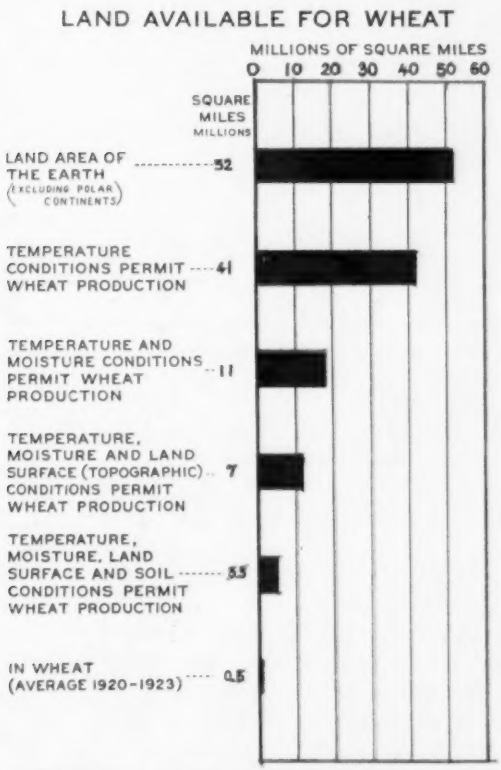
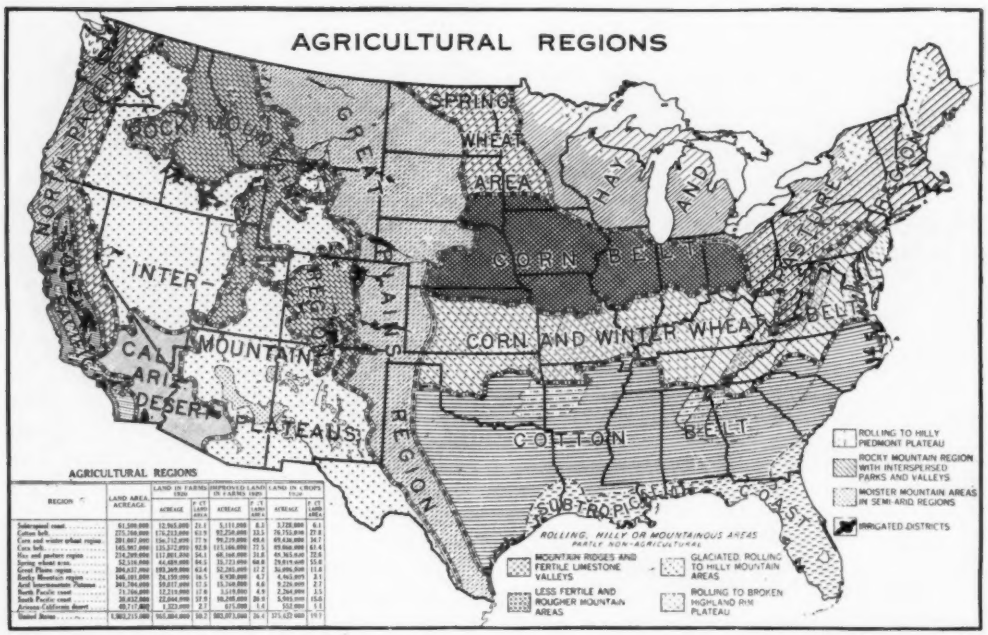

LAND AVAILABLE FOR WHEAT
MILLIONS OF SQUARE MILES
0 10 20 30 40 50 60
SQUARE MILES MILLIONS
LAND AREA OF THE EARTH (EXCLUDING POLAR CONTINENTS) 52
TEMPERATURE CONDITIONS PERMIT WHEAT PRODUCTION 41
TEMPERATURE AND MOISTURE CONDITIONS PERMIT WHEAT PRODUCTION 11
TEMPERATURE, MOISTURE AND LAND SURFACE (TOPOGRAPHIC) CONDITIONS PERMIT WHEAT PRODUCTION 7
TEMPERATURE, MOISTURE, LAND SURFACE AND SOIL CONDITIONS PERMIT WHEAT PRODUCTION 5.5
IN WHEAT (AVERAGE 1920-1923) 0.5

FIGURE 13.—Only one acre in ten of the land of the world is physically available for wheat production. Adverse climatic conditions prevent production on nearly four-fifths of the land, and of that climatically available, about 11 million acres, over one-third, is too hilly or rough for wheat cultivation, reducing the area to 7 million acres. Unfavorable soils still further reduce by a fifth the area climatically and topographically available, leaving only 5½ million acres physically suitable for wheat. But this tenth of the land surface physically available exceeds present requirements, less than one acre in ten of this available land being utilized for wheat. In other words, less than one per cent of the land surface of the earth is in wheat at present. Since corn, oats, hay, vegetables and other crops must also be grown on land suitable for wheat, it appears unlikely that over three per cent of the world's land surface will ever be devoted to wheat production.

Wheat, for instance, can be grown in portions of the Cotton Belt, but very little is produced largely because cotton has narrower climatic requirements than wheat and these are met more fully in the Cotton Belt than elsewhere in the United States, or, perhaps, in the world, for that matter (Fig. 14). Wheat can be grown from the Cotton Belt northward almost to Hudson Bay and the Mackenzie Valley, from the Piedmont Plateau on the east to the Rocky Mountains on the west and locally almost to the Pacific Coast; but the cotton crop is restricted commercially to those parts of the United States having over 200 days in the frost-free season, a summer temperature of 77 degrees or more, not less than 20 inches of average annual precipitation, and not more than 10 inches of rain in the three autumn months, since rainy weather at this season interferes with picking and damages or discolors the lint.

The area in the United States physically available for cotton is only about 40 per cent that available for wheat; and in the world the areas producing cotton are, as compared with many other crops, relatively small in extent, about 60 per cent of the world's crop being grown in our Cotton Belt. Consequently, the price of cotton is normally such, largely as a result of its narrow climatic limits, that only enough corn is grown in the Cotton Belt to meet the local demand, for reasons which will be explained under economic principle No. 2, and practically all the wheat flour is imported from the North and West. Corn, like wheat, has a wider climatic range than cotton and can be grown elsewhere.

But corn has a narrower climatic range than wheat and tends to exclude wheat from the Corn Belt, except in so far as wheat can be grown with labor not




AGRICULTURAL REGIONS

| REGION | LAND AREA, ACREAGE | LAND IN FARMS, 1920 | | IMPROVED LAND IN FARMS, 1920 | | LAND IN CROPS, 1919 | |
|---|---|---|---|---|---|---|---|
| | | ACREAGE | P. CT. LAND AREA | ACREAGE | P. CT. LAND AREA | ACREAGE | P. CT. LAND AREA |
| Subtropical coast | 61,500,000 | 12,965,000 | 21.1 | 5,111,000 | 8.3 | 3,728,000 | 6.1 |
| Cotton belt | 275,760,000 | 174,213,000 | 63.2 | 92,250,000 | 33.5 | 76,751,000 | 27.8 |
| Corn and winter wheat region | 201,667,200 | 136,712,000 | 67.9 | 99,219,000 | 49.4 | 69,436,000 | 34.7 |
| Corn belt | 145,967,000 | 123,372,000 | 84.8 | 115,166,000 | 77.5 | 95,866,000 | 65.4 |
| Hay and pasture region | 214,269,000 | 111,801,000 | 54.1 | 68,160,000 | 31.8 | 49,365,000 | 22.6 |
| Spring wheat area | 52,110,000 | 44,689,000 | 85.8 | 35,723,000 | 68.8 | 29,819,000 | 55.6 |
| Great Plains region | 304,637,000 | 193,369,000 | 62.4 | 52,283,000 | 17.2 | 36,096,000 | 11.8 |
| Rocky Mountain region | 146,181,000 | 24,159,000 | 16.5 | 9,930,000 | 6.7 | 4,963,000 | 3.3 |
| Arid intermountain Plateau | 261,784,000 | 33,017,000 | 12.6 | 15,769,000 | 6.0 | 9,226,000 | 3.5 |
| North Pacific coast | 71,766,000 | 12,219,000 | 17.0 | 3,119,000 | 4.3 | 2,264,000 | 3.1 |
| South Pacific coast | 38,432,000 | 22,044,000 | 57.3 | 10,248,000 | 26.5 | 5,995,000 | 15.6 |
| Arizona-California desert | 49,717,000 | 1,323,000 | 2.7 | 615,000 | 1.2 | 352,000 | 1.1 |
| United States | 1,803,215,000 | 765,884,000 | 42.2 | 503,073,000 | 27.4 | 375,620,000 | 19.7 |

FIGURE 14.—The two outstanding agricultural regions in the United States are the Corn Belt and the Cotton Belt. Cotton and corn are the most productive per acre of the major crops, and they tend to exclude wheat from the regions suitable for them; but not wholly because wheat can be seeded and harvested at times of year when these crops, particularly corn, do not need attention. Partly because of this competition (with corn particularly), the important wheat regions are found between the Corn Belt and the Cotton Belt, in the southern portion of the Hay and Pasture region to the north of the Corn Belt, in the sub-humid Spring wheat region to the northwest, and in the semi-arid Great Plains region to the west (See Figs. 6 and 20). (Map adapted from a figure in 1921 Yearbook of U. S. Dept. of Agriculture.)

needed at that particular season for corn, as explained under economic principle No. 3. Wheat is grown extensively in many countries, especially on the sub-humid lands that occupy so large a part of the earth's surface; whereas the production of corn is climatically confined to a few areas, two-thirds of the world's production being grown in the eastern United States, and half of this two-thirds in the Corn Belt.

2. The crop or other agricultural product which has small bulk or weight per unit of value can best bear the cost of transportation and will be grown, consequently, in those regions offering the most favorable physical conditions; but not to the exclusion of more bulky crops, because a certain quantity of these bulky crops that cannot bear the cost of transportation must be grown locally to meet the local demand.

Cotton, for instance, of which the farm price during recent years has been 15 to 30 cents a pound, can be shipped to England or New England at a cost normally of 1.5 to 3 cents, or about 10 per cent of its value, of which 5 per cent is for freight and 5 per cent for commissions, storage and other market charges. Corn, on the other hand, of which the farm price in the Corn Belt in recent years has ranged from a half a cent to two cents a pound, costs on the average about 100 per cent of its value to ship to the Cotton Belt; that is, when the farm price of corn is 50 cents a bushel in Iowa or Nebraska it is usually about $1.00 in Georgia and Texas. The Cotton Belt normally imports corn and the price, therefore, is determined by the Corn Belt price plus the cost of transportation.

The Cotton Belt farmer finds it profitable, owing to this protection, to grow nearly enough corn to meet the local demand, but when he grows more than

enough he finds it very unprofitable, as occurred in Georgia in 1921. The average farm price for the state in that year dropped to 53 cents as compared with 74 cents in South Carolina and 78 cents in North Carolina. The price in Georgia would have been still lower if Georgia had not been able to sell part of its surplus to these states. If Georgia had been compelled to ship corn to the Corn Belt, it would have received nothing for its corn.

But it does not normally pay the Cotton Belt farmer to grow wheat even for home use, partly because the price of wheat is usually 50 per cent greater than the price of corn and freight charges are no higher. And if flour be imported, as is actually the case, the proportionate protection afforded the wheat grower in the Cotton Belt by freight charges is still smaller. The Cotton Belt, in other words, can better afford to import wheat than corn, and does so.

3. The varying seasonal requirements of the several crops and agricultural products for labor tend to diversify the agriculture of a region. The farmer must do a particular task at a definite time in the year, and he is likely to have more work than he can do at certain seasons; for instance, at planting time in the spring and harvesting time in the fall. If he can grow a crop like wheat,

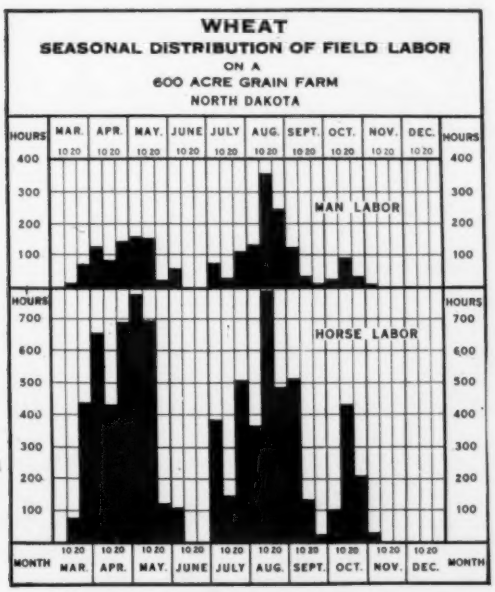



FIGURE 15.—In regions where wheat is the principal crop the heaviest demand for man labor comes at harvest time, which in North Dakota occurs during the latter half of August. The requirements for horse labor are fully as heavy in the spring. In late June and from mid-November to mid-March, there is little for the farmers to do on a wheat farm and no work for the horses. Unless the farmer can get very high pay for the days when his labor and his horses are needed, he will be compelled eventually to grow other crops, in addition to wheat, which require labor at that time of year when he is now idle. Owing to the short growing season in North Dakota, it is difficult to find such a crop. Dairying helps to provide work during the long winter. (Graph from article by author in 1917 Yearbook of U. S. Dept. of Agriculture.)

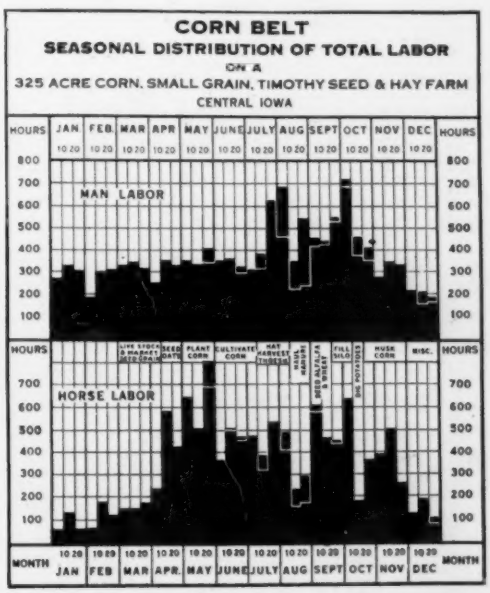



FIGURE 16.—In the Corn Belt, in addition to corn, either spring or winter grain and hay crops are extensively grown. The production of these crops provides employment for the farmer when he would otherwise be almost idle. The seasonal distribution of man labor is much more uniform than in the wheat regions. In the winter the cattle and hogs require daily attention, the buildings and machinery can be repaired, and everything made ready for the coming spring. Late winter and early springs afford the farmer his most leisurely season of preparation. The requirements for horse labor are heavy from early April to mid-November, except during the latter half of August. But even in the Corn Belt the horses have little to do in the winter time. (Graph from 1917 Yearbook of U. S. Dept. of Agriculture.)

for example, which in the southern portion of the Corn Belt can be seeded in the fall after the corn crop is removed and harvested in the summer after corn cultivation is over and before haying begins, or like oats in the northern Corn Belt, which can be seeded in the spring before corn planting time, he will do so, even though he may not receive from the small grain crop as good pay for his labor and for the use of land and equipment as from the corn crop (Figs. 15 and 16).

4. Not only is it desirable to grow such a combination of crops as equalizes the seasonal requirements of labor, but also it is important to grow such a combination of crops as will maintain soil fertility and promote freedom from insects and disease. In the United States and Europe this purpose is at least partially achieved by planting (1) an intertilled crop, commonly corn, sugar beets, or potatoes, the cultivation of which destroys weeds and prepares the land for seeding that fall or the next spring, (2) a small grain crop (wheat, oats, barley, or rye), with which (3) grass or leguminous seeds (timothy, rye grass, clover, etc.) are usually sown. The grass seeds produce a hay meadow the following year, which may be left down for pasture a fourth or fifth year. The grass roots add humus to the soil, and the leguminous plants also add nitrogen, while the cover afforded by the grass greatly lessens erosion. Wheat, or some other small grain is an essential part in such a rotation, and, consequently, is grown in some regions where it would not

FIGURE 17.—Another reason why wheat is grown in the Corn Belt, in addition to the fact that it affords work when the corn does not need attention, is the possibility of seeding it on corn stubble without plowing. It has been found that merely harrowing the corn stubble land gives as high yield of wheat the following year as plowing. Moreover, clover and timothy seed can be sown with the wheat, thus saving an extra operation and providing a nurse crop for the tender hay plants. A harrow is seen to the left in the picture, seeders to the right. (Photo by H. C. Miller, U. S. Dept. of Agriculture.)

FIGURE 18.—In most of the Corn Belt a disk harrow, shown in the picture above, is used much more commonly than the spring tooth harrow, shown in Fig. 17, in preparing corn land for wheat. The corn, it will be noted, is cut usually about eight inches above the ground, or in much of the Corn Belt it may not be cut at all, the ears of corn being husked from the standing stalks. The disk harrow turns under these corn stalks better than the spring tooth harrow. (Photo from Bureau of Plant Industry, U. S. Dept. of Agriculture.)

otherwise be produced (Figs. 17 and 18).

5. Opposed to these tendencies toward diversification is a tendency to grow the most productive crops (value per acre) on the most valuable land, and as population increases and land becomes relatively scarcer this tendency becomes stronger, since the more expensive land and more abundant labor must be profitably employed. Near the large cities, for instance, market gardening is commonly the most important system of farming. This is owing also to the perishable and bulky character of the crop, which makes transportation hazardous and expensive. Outside the trucking and fruit regions, cotton and corn occupy the most expensive land (compare Figs. 14 and 19). The great wheat producing regions are found between the Cotton Belt and the Corn Belt (in fact, almost entirely surround the Corn Belt) and in the sub-humid Great Plains Region to the west and northwest (Fig. 20). Where wheat does not succeed, oats are grown, and where neither wheat nor oats can be profitably produced, as on sandy soils, rye is grown. Beyond, far to the north, in the semi-arid regions of the West, and along the moist North Pacific and North Atlantic Coasts, where the physical conditions are unfavorable to most other crops, and land is cheap, hay is dominant. Now, the average farm values per acre of these crops in the United States during the pre-war period, 1909-1913, were as follows: Tomatoes $120.00, potatoes $59.00, cotton $22.76, corn $14.72, wheat $12.56, oats $11.51, rye $11.44, tame hay in the marginal regions about $10.00 and wild hay $6.75.

Wheat, it will be noted, ranks about midway in the list. It occupies the land not needed for vegetables or fruit or cotton or corn; but, where climatic conditions permit, is preferred to oats, rye or hay, except alfalfa or some other very productive kind of hay.

6. Lastly, but not least important, is the character of the farm population and the accumulated community skill and experience. Some people, such as the Tartar tribes of the South Siberian Steppes, have become accustomed for many generations to a pastoral life, do not know how to grow grain, and are slow in responding to the economic advantage of doing so. Wheat is not grown in many parts of the world where physical conditions are favorable because of the inertia of ignorance, and it persists as the principal crop in other parts of the world for the same reason long after new conditions have developed which would make a different system of farming more profitable. As education becomes more wide-spread and farmers more responsive to economic stimulus, this factor tends to diminish in importance, while the previously mentioned economic factors tend to increase in influence.

### THE TREND IN LAND UTILIZATION

These six economic principles are also helpful in understanding the utilization of the land for crops in competition with pasture or forest. The crops, having a narrower climatic range than pasture grasses, and also yielding normally a

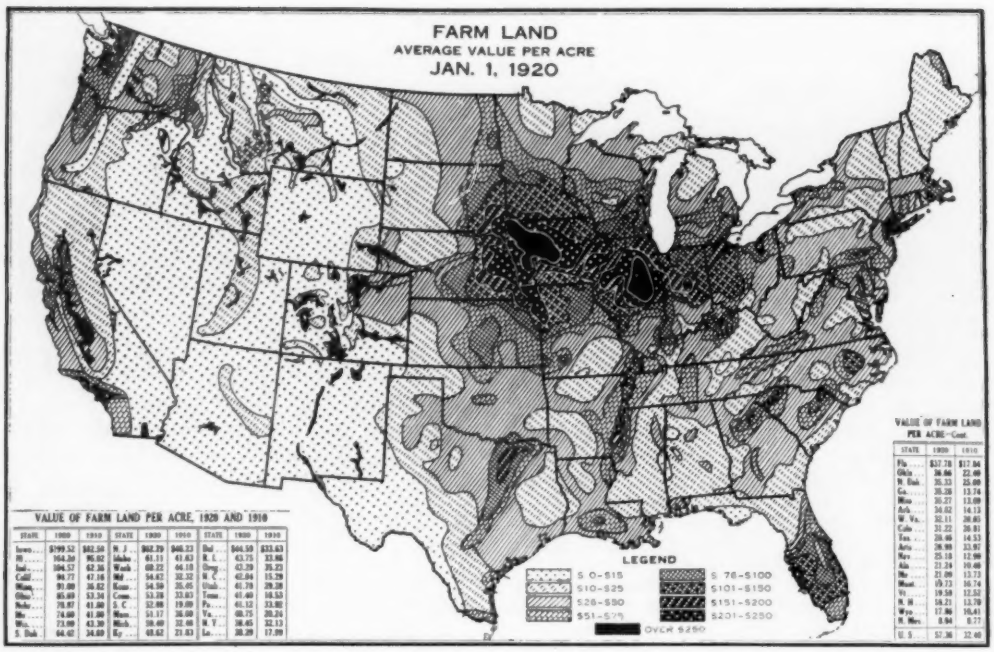



FIGURE 19.—Land values are highest where the most productive crops are grown. The Corn Belt stands out strongly in the map above, and the more fertile portions of the Cotton Belt. The irrigated areas in the West, in which alfalfa, sugar beets, and fruit are commonly important crops, all yielding a high value of products per acre, also are regions of high land values. The principal wheat producing areas, it will be noted, are regions of low to medium land values. (Map from article by author in 1921 Yearbook of U. S. Dept. of Agriculture.)

greater gross product per acre, whether measured by quantity or value, have first choice of the land, that is, crops tend to replace pasture on the more productive soils. As population increases, crops likewise tend to press the forests off the good soils, and onto the cold, the very humid, the hilly, sandy or stony lands of the world.

But some land in most systems of farming is kept in pasture in order to lessen the amount of labor required by live stock during the summer season when the crops need attention, and also because pasture promotes the maintenance of soil fertility. It is also profitable on many farms, provided the land is not too high priced, to retain a small woodlot to supply fence posts and fire wood, even on land that might be cleared for crops. Such forest products are bulky relative to value, and their cost is increased many fold by transportation over long distances, consequently the farmer often can sell to himself at retail, so to speak, at a profit.

The utilization of the land depends upon these two groups of factors, physical and economic, and there results a constant flux and readjustment in accordance with decisions as to public policy (tariffs, etc.), and according as the varying demands for and fluctuating prices of crop, pasture and forest products press with unequal weight against the more or less elastic physical conditions of climate, topography and soil. But so long as the trend of population is upward, the trend of land utilization will be downward,—toward more and more area in crops, here at the expense of pasture, there at the expense of forest land, and in most countries at the expense of both (Fig. 21).

Crops will never occupy all the land physically available, nor wheat all the crop land that is suitable, but as population increases the tendency will be for

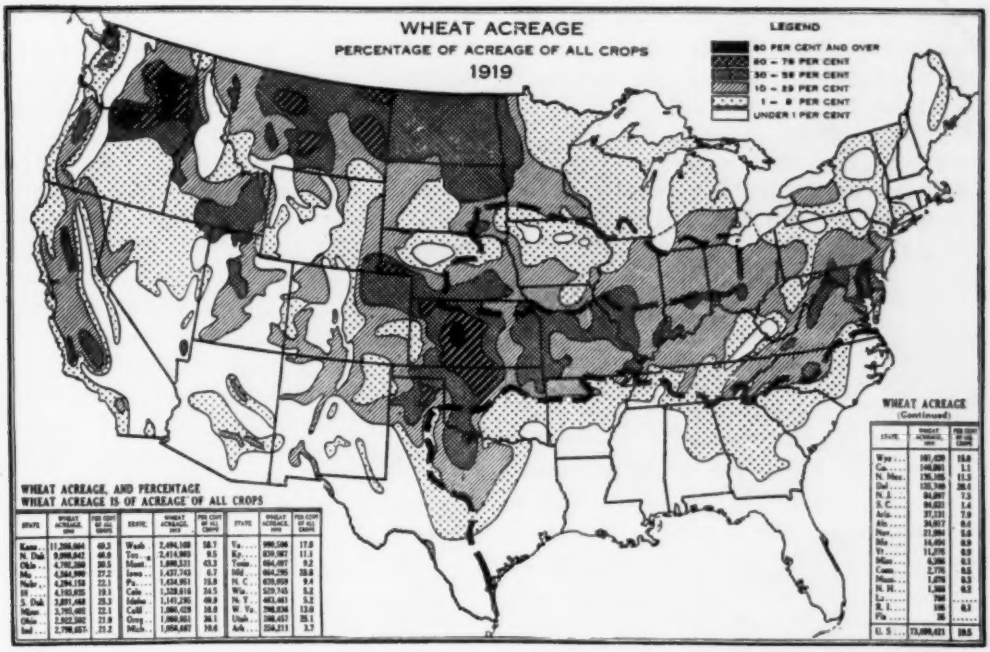

WHEAT ACREAGE
PERCENTAGE OF ACREAGE OF ALL CROPS
1919
LEGEND
80 PER CENT AND OVER
60 – 79 PER CENT
30 – 59 PER CENT
10 – 29 PER CENT
1 – 9 PER CENT
UNDER 1 PER CENT
WHEAT ACREAGE, AND PERCENTAGE WHEAT ACREAGE IS OF ACREAGE OF ALL CROPS
WHEAT ACREAGE (Continued)

FIGURE 20.—The importance of the wheat crop, as measured by the percentage it constitutes of the acreage of all crops, is greatest in the region between the Cotton Belt and the Corn Belt, which are outlined on the map, and in the sub-humid or semi-arid regions to the northwest. Cotton and corn are crops with a narrower climatic range and larger product per acre than wheat, hence they tend to have first choice of the land. In the southeast and northeast the climate is mostly too moist for profitable wheat production, and in the southwest it is too dry. (Map from 1921 Yearbook of U. S. Dept. of Agriculture.)

crop land to increase at the expense of pasture and forest, and for wheat to increase at the expense of the less productive crops. The limits beyond which this trend in land utilization seems likely to lower the standard of living, and probably impair also the productiveness of the land, vary in different countries of the world. Consequently, it appears best to consider the conditions of agricultural production separately in each of the important wheat producing countries.

## THE GEOGRAPHY OF PRODUCTION

The principal wheat producing countries in 1923 arranged in diminishing order are the United States, Canada, China (probably) India, France, Russia (probably), Argentina, Italy, Spain, Australia, Germany, and Roumania (Fig. 22). None other produced over 100 million bushels. Allowing 450 million bushels for China and 280 million bushels for Russia (including Asiatic Russia), which is less than half the pre-war quantity, the world production was about four billion bushels. Nearly one-third of this world total was produced in the United States and Canada, and about two-fifths in Europe. In other words, nearly three-fourths of the world's wheat was grown in North America and Europe.

### NORTH AMERICA

In North America, as already noted, the regions of dense production of wheat are found between the Cotton Belt and the Corn Belt and on the sub-humid plains to the westward and north-westward (see Figs. 6 and 20). Cotton and corn being plants with a narrower climatic range, also more productive per acre and requiring a larger amount of labor, have first choice of the land; but

not to the exclusion of wheat in the Corn Belt, because wheat is needed to equalize the seasonal distribution of labor and occupy an essential place in the rotation. It is interesting to note that in the southern Corn Belt, where the physical conditions are favorable to winter wheat, it is grown in preference to oats.

The densest areas of wheat production are in the sub-humid portion of the Great Plains region. In the Kansas-Oklahoma-Nebraska section practically all the wheat is sown in the fall, but in the Dakota-Prairie provinces section it is nearly all spring-sown. The yields per acre in this sub-humid and semi-arid region are lower than in the humid regions to the east, but along this marginal belt wheat can compete more successfully with corn, cotton, and other more productive crops, partly because of its adaptation to dry and cool climates, partly because of the extensive use of machinery which the crop permits, and partly, especially with relation to corn, because of the better ability of wheat to stand the cost of transportation to market. About 60 per cent of the wheat acreage of the United States is in regions having less than 30 inches average annual rainfall, including snow (Fig. 23).

TREND IN PER CAPITA ACREAGE OF CROPS, PASTURE, AND FOREST, AND AMOUNT OF LIVESTOCK, UNITED STATES, 1880–1920

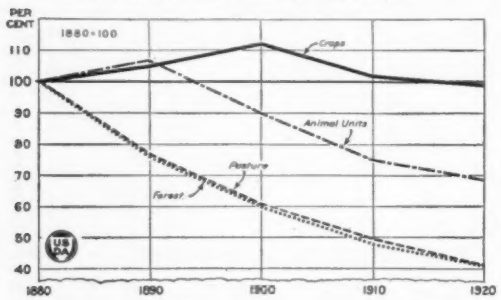



FIGURE 21.—With the progress of population crop land tends to increase at the expense of pasture and forest land. The per capita acreage of crops in the United States increased 12 per cent between 1880 and 1900 and then decreased to an amount in 1920 one per cent below that in 1880. The per capita acreage of both pasture and forest lands, on the other hand, have declined steadily since 1880 and are now only 40 per cent as great as 40 years ago. The per capita amount of livestock increased till 1890, and has since decreased at almost as rapid a rate as pasture. The general trend is toward more bread and less beef. (Graph from 1923 Yearbook of U. S. Dept. of Agriculture.)

Dense, but much smaller areas of wheat production may be noted in the humid eastern portion of the country, mostly along the southern margin of the Corn Belt. The sections of eastern North America where wheat has remained an important crop for 50 years,—southeastern Pennsylvania, the Shenandoah Valley, western New York and southern Ontario, western Ohio and southwestern Illinois—are areas of silty soils, mostly derived from limestone.

Another small wheat region, with great density of production, is located on the Columbia plateau of eastern Washington and Oregon. This district also, like the Great Plains, is a sub-humid to semi-arid area, and the soils are high in lime and very fertile. In North America, and indeed throughout the world, the persistence of wheat on moderately dry, limestone soils, similar to those in the land of its origin, is noteworthy.

Beyond these wheat regions in the central portions of the continent, to the northeast, to the north, and to the west, where the climate is too moist, too cold, or too dry, hay is the dominant crop. Much of this hay is wild hay—marsh hay in the moister regions and prairie hay in the drier—but alfalfa is dominant in the irrigated districts. Wheat ranks next to hay in importance in these irrigated areas.

Thus, we may compare a cross section view of the agriculture of the United States and Canada to that of an onion having two centers. These centers are the Corn Belt and the Cotton Belt. Between these centers and bordering them on the west, indeed almost surrounding the Corn Belt, is a belt in which wheat is a very important crop; and beyond the wheat belt is the hay belt of the northeastern states, of Canada and the Pacific Coast. Along the coastal border

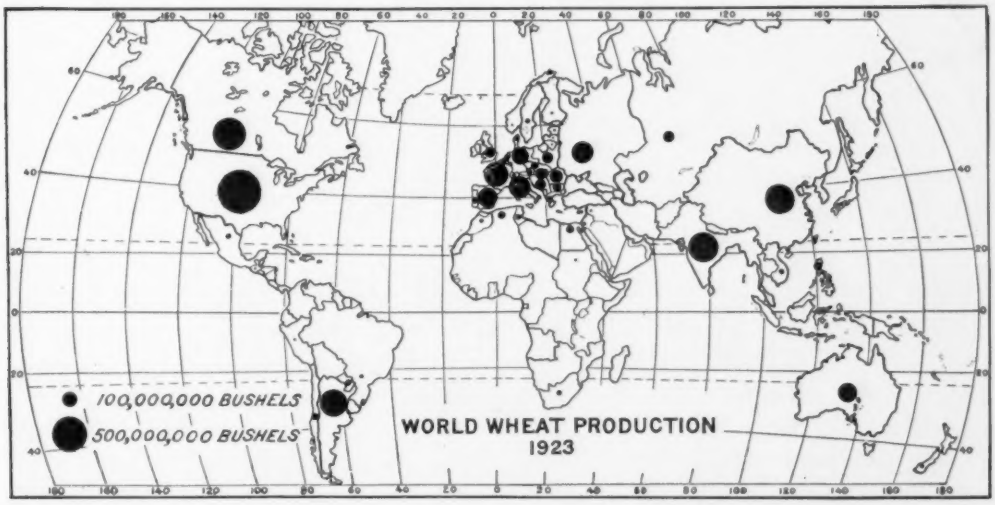
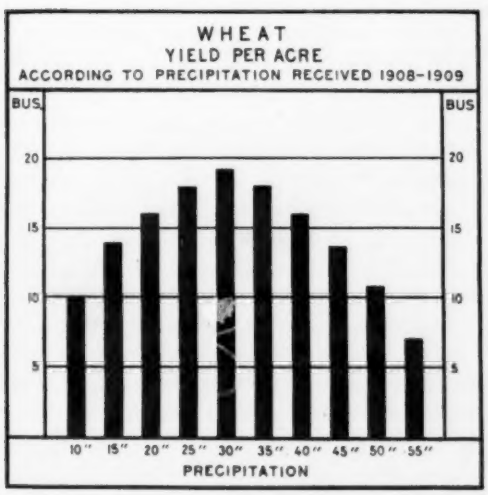



FIGURE 22.—North America and Europe produce nearly three-fourths of the world's wheat. Before the war Europe produced considerably more than twice as much wheat as North America, but in 1923 North America produced almost as much as Europe. Forty per cent of the North American production of 1,270,000,000 bushels was exported in that year, mostly to Europe. But Russia, where two-thirds of the European decrease in production occurred, imported very little of this wheat because of its economic situation. European Russia ranked with the United States in wheat production before the war; now, if the estimates are correct, it ranks with Italy and Spain. But the trend of production is upward, and in Siberia nearly half as much wheat was produced in 1922 and 1923, as before the war.



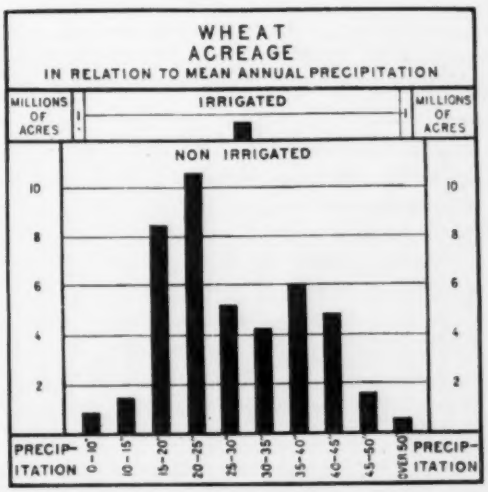




FIGURE 23.—The highest yields of wheat per acre in the United States in 1909 were in regions having about 30 inches annual rainfall. But owing to the competition of corn and other high yielding crops for the land in these humid regions, wheat is partly pressed off these more productive lands into the regions where the rainfall is only 15 to 25 inches. In these sub-humid and semi-arid regions the acre-yield of wheat is three-fourths as great as in the more humid regions, while that of corn is only one-third to one-half as great. This fact, together with the adaptation of wheat to large scale machinery and extensive methods of farming, permits it to be grown in these semi-arid regions with a profit fully equal to that from the more productive corn and cotton. (Graph from "Geography of World Agriculture," U. S. Dept. of Agriculture, 1917.)

FIGURE 24.—Seeding wheat with drills in west central Kansas. In this sub-humid region the land usually requires plowing each year. After plowing the land is harrowed, and after harrowing the wheat is sown by drills. The picture shows an eight-foot disk drill drawn by four horses, and two drills drawn by a tractor. On the large farms of the wheat areas a tractor is a useful machine because it saves both labor and time in plowing and in seeding the broad areas to wheat. In the northern portion of the spring wheat region time is especially important, as the wheat must be sown early in the spring in order to obtain the best yields and escape injury from rust, hail, drought or frost. (Photo by L. A. Reynoldson, Bureau of Agricultural Economics, U. S. Dept. of Agriculture.)

of the Cotton Belt the simile fails, for here the humid climate prevents the production of wheat and interferes with the curing of hay.

Owing partly to this competition for the use of the land with cotton and corn especially, and to the fact that wheat cannot be grown successfully in the moister portions of the United States, the crop occupies only about 13 per cent of the cultivated land. In Canada, where there is no competition from cotton and but little from corn, and where the agriculture in a large area is still in the pioneer stage, 30 per cent of the cultivated land is in wheat. If these proportions be applied to the area physically available for wheat, which is about 1,000,000 square miles for the United States and 400,000 square miles for Canada, we would have 130,000 square miles of wheat in the United States and 120,000 square miles in Canada.

As the population increases, it is probable that the proportion of cultivated land in wheat will increase in the United States, but this likely will be balanced by a decrease in Canada. The new land brought into use for crops will be of lower productivity, but the higher yields per acre on the old lands resulting from the wider use of fertilizer and better cultivation will probably neutralize these lower yields. So it seems a safe assumption to apply the present yields per acre of 15 bushels in United States and 17 bushels in Canada to these estimated areas of wheat.

FIGURE 25.—In the winter wheat and spring wheat sections of the plains, wheat may follow wheat for many years in succession. The tendency now, however, is to rotate wheat with corn or grain sorghum and a hay crop, if the climate permits. The picture was taken in Northwestern Texas and shows the mirage effect on the horizon, so common in the plains region in the early morning. The machine is a binder and the bound sheaves, which will later be picked up and shocked, can be seen to the right. (Photo from Bureau of Plant Industry, U. S. Dept. of Agriculture.)

On this twofold assumption,—that the present proportion of crop land in wheat in these countries will be maintained and that the yield per acre will remain constant—we arrive at the figure of 2,550 million bushels of wheat for the United States and Canada when the physically available wheat land is brought into use for crops. This is somewhat more than twice the present production. With the addition of the wheat areas of Mexico and Central America, it seems likely that almost three billion bushels of wheat can be produced in North America without altering greatly the present systems of farming. This is near the lower limit of potential production. Should the proportion which the wheat area of France bears to the cultivated land (28 per cent) be applied to the area physically available for wheat in the United States, while the proportion in Canada remains as at present (30 per cent), and the yield per acre in both countries be increased to that in France today (20 bushels), the United States and Canada would be able to produce nearly 6 billion bushels of wheat, or over four times the present quantity.[8] This is near to the

[8] France is selected as a basis for the estimate because climatic conditions are comparable with those in North America, and much less mineral fertilizer is used than in Germany or Great Britain. French farmers maintain this moderate yield of wheat per acre principally by means of rotation of crops, barnyard manure and good cultivation. It is impossible in this brief paper to enter into a discussion concerning the necessity of mineral manures to the maintenance of soil fertility. The use of such fertilizer will undoubtedly become increasingly profitable as farm products rise in price; but the production of wheat for centuries in Roumania, Italy, and parts of France on soils which have never received any artificial fertilizer indicates that a moderate acre yield of wheat can be maintained on many soils without such fertilizer, provided appropriate agricultural practices are followed.

FIGURE 26.—In California and the Pacific northwest headers are often used in harvesting wheat. These machines cut off the heads, which are conveyed by a belt to the header wagon that is kept alongside the header. The load of wheat heads is then carried to the threshing machine, or is ricked for threshing later. This method saves handling the straw, but is adapted only to certain varieties of wheat that do not shatter when ripe, and to regions of dry summer climate where the wheat can remain standing, after being fully ripe, without injury from rain. These dry summer conditions exist also in most of Australia and the Argentine, but the harvesting machinery used in these countries pulls off instead of cuts off the heads. (Photo from Bureau of Plant Industry.)

maximum production, and it is doubtful if it will ever be attained.

## EUROPE

In Europe both physical and economic conditions are somewhat different than in North America. The drier lands lie to the east instead of the west and the climate is too cool for cotton, and also in most of the continent too cool for corn. In much of Europe wheat becomes the most productive and valuable crop that can be grown.[9] It has therefore, in general, first choice of the land, and is produced on the best soils. The densest areas of production are in northern and western France, northern Italy, the Hungarian Plain, old Roumania and the Black-earth belt of southern Russia (Fig. 7). For the most part these are areas of limestone soils, or of soils rich in lime; also these areas, except in portions of Italy, are plains, or quite level lands. In western and central Europe the wheat is nearly all fall sown, but in southern Russia the drier and colder winters cause more of the wheat to be sown in the spring, except in Bessarabia, the Crimea and the region adjoining the Caucasus.

In the southern portion of this European wheat belt, corn is the principal intertilled crop, particularly in the Danube and Po Valleys, and alfalfa is an important hay, these constituting the

[9] Exception must be made of the Danube Valley and northeastern Roumania, of Italy and parts of Spain and Portugal, in which countries considerable corn is grown; also of Germany and Poland in which potatoes are very important, and of small districts in several countries in which sugar beets are grown.

FIGURE 27.—The combined harvester or "combine", shown above, cuts, threshes and sacks the grain as it moves across the field. It may be drawn by horses (32 are shown in the picture), or tractors, either steam or gasoline or self propelled. The combine marks the maximum development of agricultural machinery, harvesting 25 to 60 acres of wheat a day. It is adapted to very large ranches. But as these large ranches are cut up into family size farms, the large combine is being replaced by a small combine that can be operated by 2 men. Many of the smaller farmers use binders instead, which can be operated by the farmer alone. (Photo from Bureau of Plant Industry.)

principal features of the rotation and providing a fairly uniform seasonal distribution of labor. Along the northern margin of the belt, in northern France, central Germany, Czecho-Slovakia and parts of the Ukraine, sugar beets become locally the intertilled crop. Elsewhere in this wheat belt potatoes are the intertilled crop. Clover and the rye grasses are the important hay plants.

To the north of this wheat belt, as in the humid eastern half of North America, wheat is replaced by rye and oats, the potato is the important intertilled crop, particularly in Germany and Poland, and the area in hay increases.

The agriculture of Europe, therefore, is not somewhat concentric, as in North America, but belted, with wheat a very important crop in the southern and central zones of latitude, oats and rye in the northern zone, and even these hardy crops almost disappear in the extreme north, leaving principally hay, potatoes and a little barley and truck. The national agriculture in western and central Europe (excluding Great Britain) is largely self-sufficing, and this is true also of Russia and Roumania at present. Nearly every nation endeavors to be self-maintaining and erects tariff barriers at its boundaries. Differences in transportation costs do not affect the distribution of the crops as much as in the United States, and although the diet is less varied the local agriculture in western and central Europe is more diversified, since most of the food must be produced near the place of consumption.

The population is denser in Europe than in North America and less wealthy; less meat, sugar, fruit, and fancy foods

FIGURE 28.—Cutting wheat with a scythe and cradle in Arnold Valley, near Natural Bridge, Virginia, in 1911. One man can cut about three and a half acres a day. The wheat dumped by the cradle after each swath is tied by hand and then piled in a shock. Later it is threshed with a flail or a primitive threshing machine. In many little valleys in the Appalachian Mountains, in which only a few acres of small grains are grown, the farmers do not have modern harvesting machinery. Nearly all the wheat is grown for home use and is ground on shares at the local grist mill. (Photo by W. Elmer Ekblaw.)

are eaten but more bread (Fig. 3). Consequently, a larger proportion of the cultivated land is in wheat, and, in addition, large quantities are imported. In the United States, as already noted, 13 per cent of the cultivated land is in wheat, and 10 per cent would suffice for domestic needs; whereas in France, prior to the war, 28 per cent of the cultivated land was in wheat and 5 per cent in rye, in Italy 35 per cent in wheat and 1 per cent in rye, in the former Austro-Hungarian Empire 20 per cent in wheat and 12 per cent in rye, in Germany 8 per cent in wheat and 24 per cent in rye, and in Russia 20 per cent in wheat and 26 per cent in rye. In Germany, it will be noted, rye is a much more important bread grain than wheat and in Russia rye is fully as important, whereas in the United States only 1 per cent of the cultivated land is in rye. In the United States 14 per cent of the cultivated land is in bread grains, and one-quarter of the product is exported. For Europe as a whole about 40 per cent of the cultivated land is in bread grains,—22 per cent in wheat and nearly 18 per cent in rye.

Were a larger proportion of the cultivated land in Europe devoted to bread grains, it is doubtful if the fertility of the soil could be maintained. The possibilities of increasing wheat production in Europe, therefore, seem to lie not in a general increase of the proportion of cultivated land in wheat, but rather in the expansion of the cultivated area and in larger yields per acre. Of the 1,500,000 square miles of land which it is estimated are physically available for wheat in Europe, only two-thirds is cultivated at present, the remaining one-third being in pasture or forest. Were this area devoted to wheat and other crops and to rotation pasture in the present proportions, the production of wheat would be increased perhaps one-third, since the land not cultivated at present is undoubtedly of lower fertility than the present cultivated land. And if, in addition,

FIGURE 29.—In Europe much of the wheat is still harvested with the sickle and the bundles are tied by hand. Both men and women work in the field. The picture was taken in northern Spain, and was supplied by the Keystone View Company.

the yields per acre of the wheat lands in Russia could be increased to the average for France (20 bushels), the wheat production of Europe, which averaged nearly two billion bushels during the five years preceding the war, could be increased to over three and one-half billion bushels. This would involve no serious alteration in the systems of farming, except in Russia.

### ASIA

In Asia the principal centers of wheat production are in western Siberia, China and India. The wheat area in Asiatic Russia is a continuation of the European belt. The "Black-earth" soils extend across the low Ural mountains almost to Irkutsk, but east of Tomsk the belt is narrow and broken. Most of the wheat is grown in this sub-humid, "Black-earth" belt and on the semi-arid, chestnut-colored soils along its southern margin. Only a little wheat is grown in the forest region to the north of the "Black-earth" belt. A little wheat is likewise grown in the Amur Valley in Eastern Siberia (Fig. 8).

Western Siberia and the Steppes to the south constitute the largest area in the world of virgin land available for wheat. If 30 per cent of the 500,000 square miles physically available for wheat were devoted to this crop, and the yields per acre

were increased to the present average in the United States (15 bushels), Asiatic Russia would produce over 1,400 million bushels of wheat. The average production during the five years before the war was only 11 per cent of this amount.

In China, the production of wheat appears to be increasing rapidly, if the official estimates are even approximately correct, and the production of rice decreasing even more rapidly. In 1914 and 1915, the area of rice exceeded considerably that of wheat, according to these estimates, but in 1916, wheat was in the lead and by 1918 (after the evident error for Honan is corrected) the area in wheat was almost double that in rice. There is now, apparently, almost as large an area in wheat in China as in the United States, but owing to the system of interplanting wheat with other crops the production is probably considerably smaller (Fig. 11).

The proportion of the land in China which is arable is surprisingly small. The estimate given in the *Statesman's Yearbook* is only about 200,000 square miles; but it would seem almost certain that China, with a population about equal to that of India, must have an area of arable land approximately as great, or nearly 470,000 square miles. The Chinese official estimate of land in field and garden crops is over 300,000 square miles. Undoubtedly not all the potential arable land of China is cultivated at present, owing largely to the devastation by brigands and lack of protection of property. So it is assumed that the area in China, including Manchuria, physically available for crops is 630,000 square miles. This is less than half the area in the United States.

Since the southern third of China is too humid for wheat, it would seem, on this basis, that the area physically available for wheat is about 400,000 square miles. At present, according to the Chinese statistics about one-fourth of the area in "field and garden crops" is in wheat. Applying this proportion to the area physically available for wheat we reach the very rough and tentative conclusion that 100,000 square miles in China could be put into wheat, after some years of peace and protection, without greatly altering the present systems of farming. If this area yielded per acre only as much as the yield in the United States at present, the production of wheat in China would rise to nearly one billion bushels, an amount which has been reached in the United States only once.

The wheat area in India centers in the sub-humid Punjab district in the northwest and extends in diminishing density down the Ganges Valley toward the humid southeast and south (Fig.10). Only a little wheat is grown beyond the line of 50 inches annual rainfall, and practically none where the rainfall averages more than 70 inches yearly. In the humid portion of India rice replaces wheat. The arid limit of wheat production in India is about 20 inches annual rainfall. Despite the density of population wheat is a very important crop in India, apparently because of its adaptation to the sub-humid portion where rice cannot be grown and where corn is, in general, not a profitable crop.

Wheat occupies in India about 12 per cent of the cultivated land and rice 30 per cent. As in Russia, grains grown wholly for human food constitute fully half of the crop land. This is a greater percentage than is desirable from the standpoint of maintaining soil fertility, and any increased production in India must come, probably, from an expansion of the crop land or from higher yields per acre. It appears possible to increase the cultivated area about one-fourth, but owing to the poverty of the people and inability to pay for fertilizer, also to the fact that moisture in much of the wheat area is the limiting factor, it is improbable that the yield per acre will increase, unless there be a large expansion of irrigated land in the arid and semi-arid sections. A fourth increase in area, with the present acre yield, except a small allowance for extension of irriga-

tion, would permit a potential production in India of 500 million bushels.

About 40,000,000 bushels of wheat are produced in the normal year in Japan and its possessions, and before the war the average annual production in Persia was 16,000,000 and in Asiatic Turkey 35,000,000 bushels. After allowing a small quantity for Arabia, Afghanistan and Chinese Turkestan, it would appear that the production of wheat in these Asiatic countries of minor importance may amount to 125,000,000 bushels at present, and that perhaps 200,000,000 bushels could be raised were the demand sufficient.

### AFRICA

The principal wheat producing regions of Africa are the Mediterranean Coast, Egypt, Ethiopia, and the South-African Union; but the production in Africa is small compared with that of North or South America, Europe or Asia. Whether the vast areas of land on the East African Plateau and along the southern and northern margins of the Sahara physically available for wheat will be so used will depend principally upon the competition of other crops, and this is a question that only the future can answer. From 4 to 5 per cent of this potential area is in wheat at present, and the prospect for a large export trade is remote. But assuming that 25 per cent of the potential wheat land will eventually be utilized for wheat (it is 30 per cent in Algeria and 25 per cent in the Union of South Africa at present), and that the yield per acre will be ten bushels (which is a little above the present average yield), the potential production of Africa is about 800 million bushels.

### SOUTH AMERICA

The production of wheat in South America is practically confined to Argentina, Chile and Uruguay, with a few acres in the state of Rio Grande de Sul in Brazil and in Peru. Nearly 85 per cent of the acreage is in Argentina and practically all this Argentine wheat is grown on the pampas, a region similar to the prairie region in the United States and the "black-earth" portion of the plains (Fig. 9).

The area of wheat in Argentina since the war averages annually about 25,000 square miles, which is approximately 6 per cent of the 400,000 square miles previously estimated as the area physically available, and in the other South American countries there are about 5,000 square miles in wheat, which is 5 per cent of the probably available area.[10] Nearly 40 per cent of the cultivated land in Argentina is in wheat, but as the agriculture becomes more mature, this will undoubtedly decrease to 30 per cent, as in Canada, or even less. Assuming that 30 per cent of the physically available land will be seeded to wheat eventually, and that the acre yield will be as high as in the United States today (15 bushels), the potential production of South America may be estimated at 1,300,000,000 bushels.

### AUSTRALASIA

In Australia, the wheat belt lies between the humid southeast and southwest coasts and the arid interior. Between the 10 and 20 inch rainfall lines for the months April to October inclusive, which are considered by Australian statisticians and geographers as the boundaries of the wheat belt, lie about 150,000 square miles physically available for wheat. Of this area about fifteen thousand square miles, or 10 per cent, is in wheat at present (Fig. 12).

Nearly half of the cultivated land in Australia is in wheat, but this is too great a proportion for a permanent agriculture and it will probably decline to 30 per cent, as in Canada and France, within a few decades. The average yield

[10] On a recent trip to South America Dr. C. F. Marbut, Chief of the U. S. Soil Survey, ascertained that large areas of land in Argentina are underlaid by a heavy clay subsoil or by hardpan. Unless some method is devised of remedying this defect it appears that this estimate of the area physically available for wheat is much too large.

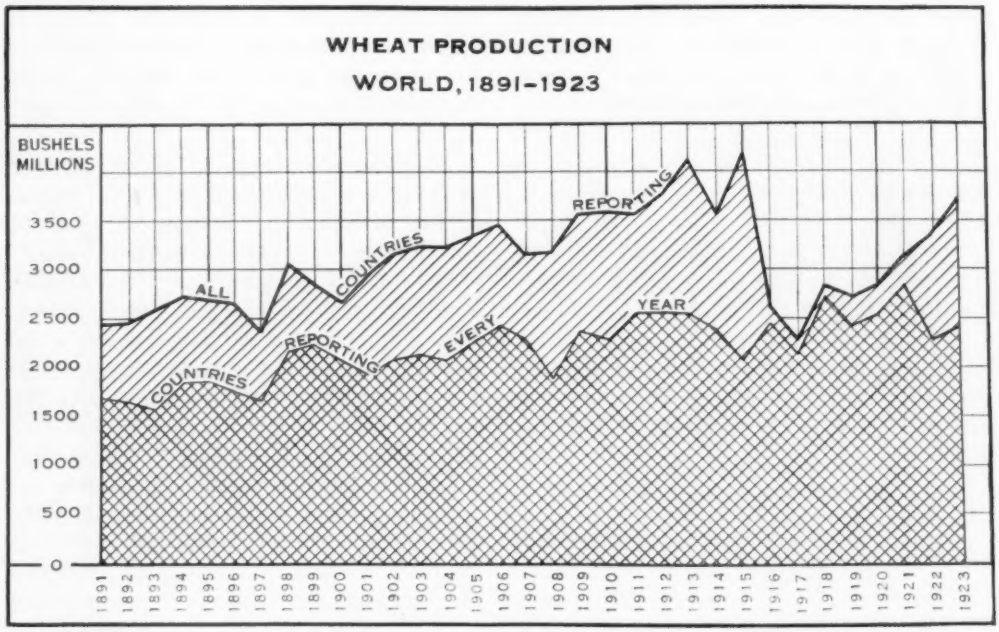



FIGURE 30.—The production of wheat in the world increased about a billion bushels between 1891 and 1911, or 40 per cent. This increase of nearly two per cent a year was more rapid than the increase in the world's population. The production rose to over four billion bushels in 1913 and again in 1915. Then came the decrease in Europe caused by the war. But the rebound in western Europe has been vigorous, and production in North America has increased rapidly, so that by 1923 the world's production had attained the 1911 level. (Graph from 1921 Yearbook of U. S. Dept. of Agriculture, with curves extended to include latest data.)

per acre is 12 bushels at present. This might possibly be increased to the present United States yield of 15 bushels. If 30 per cent of the physically available area yielded wheat at the rate of 15 bushels per acre, Australia would produce about 430,000,000 bushels, which is four times the present production. If the wheat production in New Zealand, about 9,000,000 bushels, increased three fold, Australasia would produce about 450,000,000 bushels of wheat.

## THE POTENTIAL PRODUCTION OF WHEAT

The potential production annually of wheat, therefore, may be roughly estimated as follows:

| | *Bushels* |
|---|---|
| North America | 3,000,000,000 |
| Europe | 3,500,000,000 |
| Asia | 3,100,000,000 |
| South America | 1,300,000,000 |
| Africa | 800,000,000 |
| Australasia | 450,000,000 |
| World | 12,150,000,000 |

But of these twelve billion bushels, nearly three billion bushels will be produced, and probably consumed, by non-white peoples. This leaves about nine billion bushels for the white race, which affords a comfortable surplus over the seven billion bushels estimated as required a century hence. It will require more than a century at the rate of increase in wheat production from 1890 to 1910 to achieve this potential production of wheat (Figs. 30 and 31).

This production, however is predicated upon the somewhat more extensive use of commercial fertilizers than at present, particularly in America and Europe, and upon the development in all the world, except India and China, of a live stock husbandry, to supply manure for the production of grain. It involves, consequently, the application of a greater amount of capital per acre than is utilized in most countries at present, and a widespread increase in agricultural knowledge

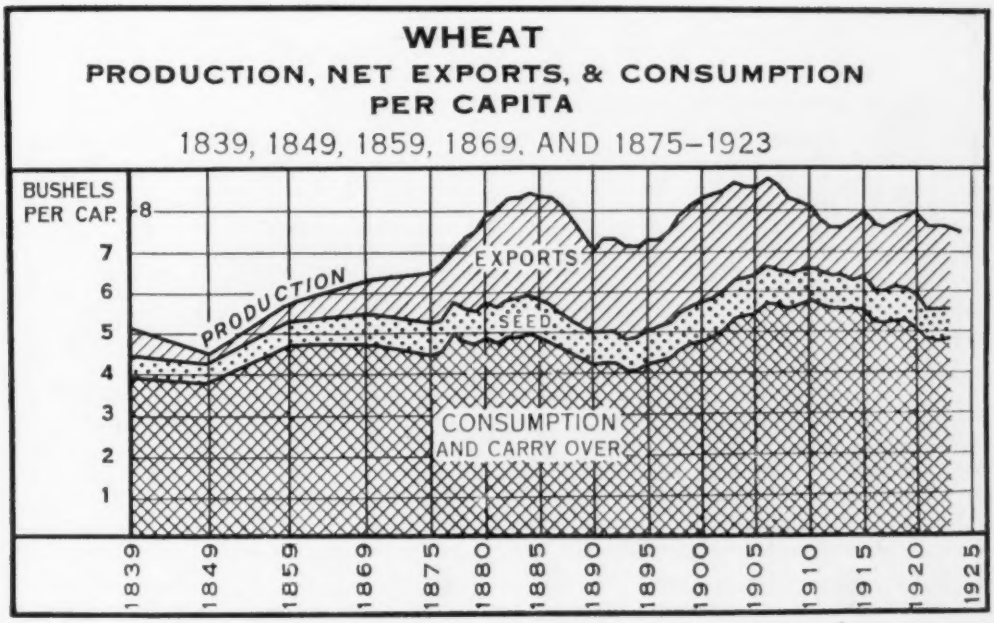



FIGURE 31.—Wheat production in the United States increased more rapidly than population from 1840 to 1880, that is, per capita production rose; and from 1880 to 1920 this per capita production (top line in the graph) was well maintained. Consumption per capita, excluding seed, (bottom line) has increased from four bushels in 1840 to five bushels today, but reached nearly six bushels about 1910. The exports increased about as rapidly as the population from 1880 to 1905, then decreased to about one-half by 1913, then rose again during the war and are now almost as great as ever. The United States, in other words, shows no diminishing ratio as yet between wheat production and population. (Graph from 1921 Yearbook of U. S. Dept. of Agriculture, with curves extended to include latest data.)

and skill. It assumes also that the price of wheat will be such as to reward the farmer adequately for his labor, his managerial ability and the use of his capital; and, above all, that peace and order and technical progress will become increasingly pervasive.

The developments of the past decade indicate that this assumption is not fully justified. If wars continue to recur, the increase of agricultural production will be retarded much more than the increase of population, and the surplus of wheat indicated above will almost certainly become a deficit (compare Figs. 32 and 33). The estimate of production that has been made considers primarily the physical limitations in the various parts of the world.

It should be noted further that the expansion of crop land, mostly at the expense of pasture, as well as the vast increase in population, will involve in the Anglo-Saxon countries a large per capita decrease in the consumption of animal products, more especially meat, which must be balanced by an increased consumption of vegetable products. The diet, in other words, will be sufficient for health and efficiency, but will resemble that in Europe before the war. Moreover, it is very probable that the utilization of so much lower grade land for crops will require a larger proportion of the world's labor and capital than today and that the price of farm products relative to those of other products will rise.

The tendency toward diminishing returns will become more and more evident as the margin of wheat production is pushed farther and farther back into the cold, the wet, the dry, the hilly, the stony and sandy lands of the world. The physical factors of temperature, moisture, topography and soil are per-

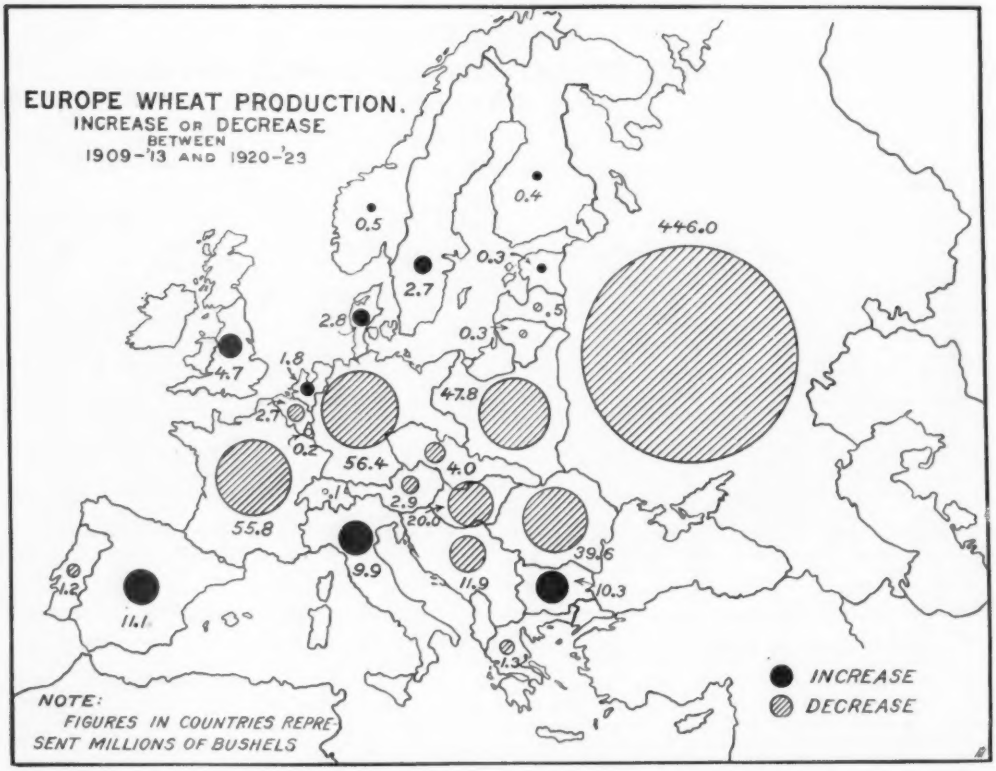



FIGURE 32.—War affects manufacturing and commerce very greatly, agriculture somewhat less, and population least of all. Wheat production in Europe decreased a third between the pre-war and post-war periods, as shown on the map, yet population apparently increased in all these countries except Russia and France, and in France the decrease was small (see Fig. 2). Although war, famine, and disease have taken a terrible toll in Russia, the population estimates indicate a decrease of less than 13 per cent between 1913 and 1920. Wheat production, on the other hand, decreased about 70 per cent, coal about 75 per cent, iron ore 97 per cent. Even more pitiful is the prospect that most of the peoples of Europe, owing to this progress of population while both agricultural and industrial production are depressed, will never regain their former standard of living. (Map copyrighted 1925 by O. E. Baker.)

manent and alterable only within narrow limits; like a spring each of them yields under pressure, in varying degree, but there is a limit of elasticity beyond which increasing pressure is futile; and even before this limit is reached the cost of the increased pressure exceeds the returns.

Agriculture, not mining or manufacturing, will eventually determine the limits of the world's population. The reserves of coal and iron are adequate to support our civilization for many hundreds, perhaps for several thousand years. Industry can continue to develop and give employment to increasingly larger numbers of workers far beyond the time when the arable land will have reached such a stage of productivity that further intensity of cultivation is unprofitable. Not many people will starve; but, as in Europe recently, the death rates will rise, especially the infant death rates, while the hours of labor will lengthen and the lower standard of living will make people more susceptible to disease.

It is certain that if the population of the United States continues to increase for more than another century as it has during the past century there is no means by which the present standard of living can be maintained, except by importation of foodstuffs from other

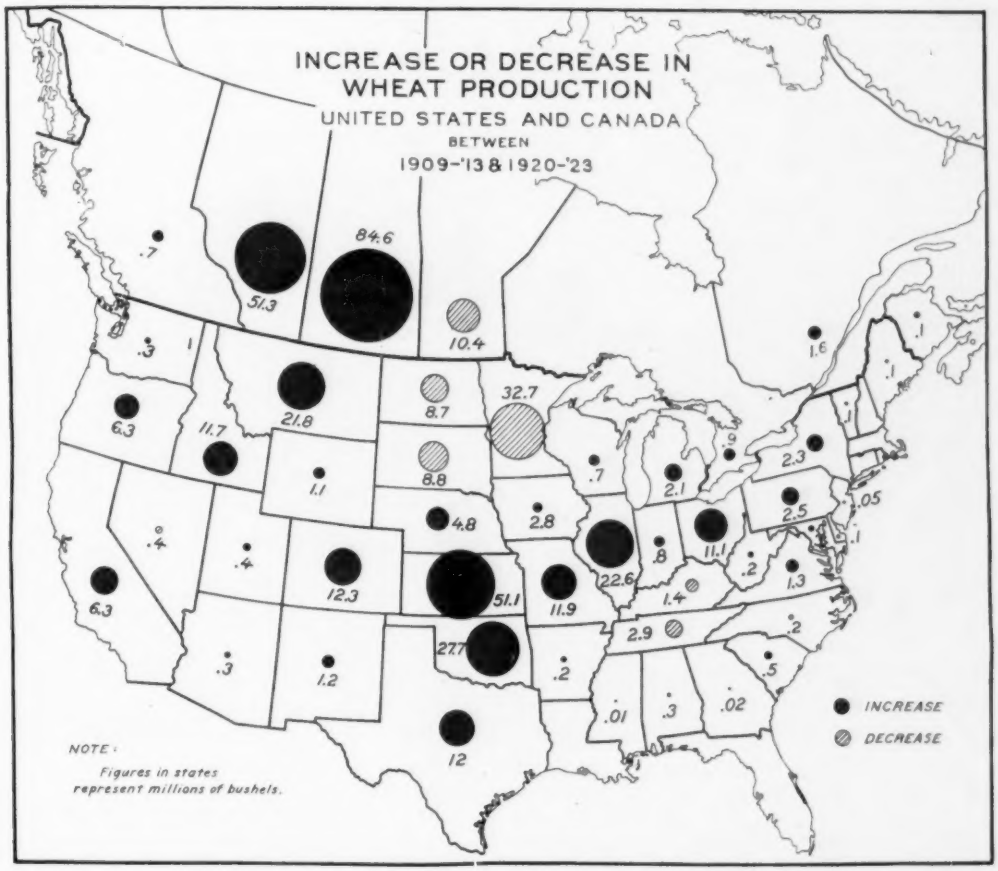



FIGURE 33.—The increase in wheat production in North America during the war years was almost equal to the decrease in Europe. The increase in North America was widespread, but was most notable in the winter wheat belt extending from Ohio to Colorado and Texas, and in the spring wheat region of Saskatchewan, Alberta and Montana. It is interesting to note that whereas Kansas and Oklahoma have greatly increased their production of wheat, the former center of spring wheat production in Minnesota, the Dakotas and Manitoba shows a notable decline. This decrease is partly owing to adverse seasons, partly to a trend toward the production of other crops and a general system of farming. (Map copyrighted 1925 by O. E. Baker.)

lands,—which will need their foodstuffs even more than we. And looking forward 200 or 300 years, which is a shorter span of time than that elapsed since the settlements at Jamestown and Plymouth, it seems necessary to recognize not only a stationary population in this country, but also throughout the world. Whether this stationary state will be one of misery for the majority of the people, as in China and India today, or one of well-being and happiness will depend largely upon voluntary restriction of population.

Nevertheless, it is clear that if occidental civilization during the next 100 years relapses into the condition of poverty and political corruption that characterizes most of the orient, the failure will arise from the dying out of the more capable people, from decline in individual initiative, and from neglect to use the scientific knowledge that has accumulated and the agricultural implements that have been devised, rather than from the niggardliness of nature. There is left to the white man a century of grace, in which to develop that rational direction and control over himself that he has so successfully applied to nature dur-

ing the past century. The trend of birth rates in the United States, Canada, and Australasia, considered in conjunction with the natural resources, is encouraging; but for nearly all other countries the prospect is not so hopeful.

FIGURE 34.—A busy day at a country elevator.

# THE GRAIN TRADE OF MONTREAL

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THE dominant activity of the port of Montreal is the movement of grain in transit to northwestern Europe from the Prairie Plains of Canada (Fig. 1) and the corn and winter wheat belt of the United States. Half the total value of the exports of the port consists of grain, and an even greater portion of the tonnage. Of this grain, export wheat forms the larger part, being sixty-five per cent of the Canadian grain handled and fifty-four per cent of the total.

That Montreal occupies a position in the grain trade of Canada far in advance of other Canadian ports, is convincingly shown by the accompanying Table I. In the four year period 1918–1922 the total volume of overseas export-grain passing through Montreal was four times as great as that through St. John, its nearest competitor, and ten times as great as that through all the others; and during this same period all the Atlantic ports of the United States exported only a third more Canadian grain than did Montreal.

An important influence in the relation of the grain exports of Montreal to the total of Canada, is the amount exported from the Dominion into the United States. As this amount increases so the overseas exports through Montreal correspondingly decrease; and since the port has only a negligible share in this export across the border, this part is wholly lost.

During the season of navigation on the St. Lawrence the port of St. John, so far as its grain handling facilities are concerned, is idle. About seventy-one per cent of the exports of Canadian grain through United States Atlantic ports moves during the closed season of navigation at Montreal, and eleven and a half per cent just previous to the close of the season. Thus, from May to November, inclusive, Montreal is the only important port for the exportation of Canadian grain. Moreover, during the last four years an average of eleven and a half per cent (38½ million bushels) of the total exports of United States grain was handled through Montreal, and in the crop year 1921–1922, 81½ million bushels of United States grain were exported through the port of the St. Lawrence.

TABLE I

Exports of Canadian Grain in Millions of Bushels by Ports and Groups of Ports for the Crop Years Ending August 31, 1918–19, 1919–20, 1920–21, and 1921–22[1]

| | 1918–19 | 1919–20 | 1920–21 | 1921–22 |
|---|---|---|---|---|
| Total Canadian Exports | 83.1 | 93.4 | 181.7 | 205.2 |
| I. Total Overseas Exports | 73.2 | 83.2 | 126.3 | 184.3 |
| A. Through Canadian Seaboard Ports | 43.6 | 60.2 | 62.4 | 66. |
| 1. Montreal | 30.4 | 41.6 | 52. | 46.9 |
| 2. St. John | 9.2 | 15.1 | 9.3 | 9.9 |
| 3. All others | 4. | 3.4 | 1.1 | 9.2 |
| B. Through United States Atlantic Ports | 29.6 | 23. | 61.2 | 118.3 |
| II. To the United States | 9.8 | 10.2 | 55.4 | 20.8 |
| A. Into Eastern United States by Lake | 8.2 | 3.3 | 34.3 | 18.5 |
| B. Into Eastern United States by Rail | .6 | 2.5 | 3.5 | 1. |
| C. Into Western United States by Rail | .9 | 4. | 16.5 | 1. |
| D. Into Western United States by Ocean | .1 | .3 | .7 | .2 |

[1] Compiled from *The Grain Trade of Canada* for the crop years ending August 31, 1918–19, 1919–20, 1920–21, and 1921–22, Dominion Bureau of Statistics, International Trade Branch.

FIGURE 1.—A Large Wheat Farm near Indian Head, Saskatchewan. The grain of the prairie plains of Canada, one of the great surplus wheat producing regions of the world, is grown more than 1,000 miles from the sea, yet it moves to the seaboard principally by cheap water transportation on the Great Lakes waterway and its eastern tributaries. (Photo by Canadian Pacific Railway Company.)

## REASONS FOR MONTREAL'S IMPORTANCE AS A GRAIN SHIPPING PORT

The importance of Montreal as a great grain shipping port is due in a large measure to (1) its location with reference to rail and water routes from the Prairie Plains of Canada and the corn and winter wheat belt of the United States, (2) the facilities for handling, the method of handling, and the cost of transfer of grain in Montreal, and (3) the availability of ocean tonnage, the freight rates, and the insurance rates from the port to the market overseas.

### THE POINTS OF CONCENTRATION OF GRAIN AT THE HEAD OF THE GREAT LAKES

Grain is forwarded to Montreal from four centers at the head of the Great Lakes, namely; Fort William-Port Arthur (Fig. 2), Duluth-Superior, Chicago, and Milwaukee.

The grain from the Prairie Plains of Canada concentrates at Winnipeg and, except a small amount to Duluth-Superior via Fort Francis, most of it moves over three railway lines to the terminal elevators in Fort William and Port Arthur where it is graded and held for shipment (Fig. 3). The grade given the grain here is that on which it is sold and delivered in both eastern Canada and foreign markets. By holding the grain at the head of the Great Lakes, the shipper can market his grain through either Canadian or United States channels. Therefore, to function effectively the port of Montreal must afford facilities equal to those of competitive ports and routes; the great flow of grain is so liquid that a saving of a fourth of a cent per bushel will divert it from established channels to new ones.[2] Canadian grain only is forwarded from Fort William-Port Arthur, while some Canadian and a larger amount of United States grain moves from the Spring Wheat Belt to Montreal from Duluth-Superior. Only United States grain is shipped from Milwaukee and Chicago to Montreal.

Grain from the corn and winter wheat belt of the United States concentrates at Chicago; in fact, Chicago is the largest

[2] Barnes, J. H., "The Great Lakes Seaway," *Review of Reviews*, August 1922, 66:184.

FIGURE 2.—Fort William, Ontario. An important link in the Great Lakes-St. Lawrence Route. The numbers of boats are suggestive of the enormous traffic in grain during the Autumn. (Photo by Canadian Pacific Railway Company.)

primary grain market in the world.[3] From Chicago export grain moves to the Atlantic seaboard by a number of routes, including those to Montreal. The facilities for the transportation of grain from these centers of concentration to Montreal determine, in a large measure, its importance as a grain port.

## THE ROUTES OF GRAIN SHIPMENT FROM THE HEAD OF THE GREAT LAKES TO MONTREAL

The routes of grain shipment to Montreal from the head of the Great Lakes include (a) the all water route, (b) the lake and rail routes, and (c) the all rail routes. It is necessary to portray the significance of the factors underlying the importance of each. Figures 4 and 5 show the movement of Canadian and United States grain respectively from the head of the Great Lakes to Montreal and from there to the sea. The charts do not include grain which goes to United States lake ports. The flow of Canadian grain through United States ports will be discussed subsequently.

[3] *Report of the Federal Trade Commission on the Grain Trade*, Vol. II, Washington, 1920.

## THE ALL WATER ROUTE

Only 5½ per cent of the Canadian grain which reaches Montreal moves by water from the head of the Lakes to the port by continuous water passage. Theoretically, the bulk of the grain from Fort William-Port Arthur should go by water to Montreal without transhipment. A number of factors, however, operate to prevent this.

The large boats on the Upper Lakes cannot proceed below Port Colborne at the Lake Erie end of the Welland Canal. Each boat in the through service to Montreal has a carrying capacity of less than 100,000 bushels, for it must be able to navigate the fourteen-foot channel of the present Welland and St. Lawrence Canals. The advantage that the larger boats have in the economical transportation of grain as against the smaller steamers tends to restrict through shipments to Montreal.

Were it possible for the large lake ves-

FIGURE 3.—Fort William, Ontario. (Photo Natural Resources Intelligence Service, Canada.)

sels to go through to Montreal, they would have to return in ballast because of lack of return cargo at that place. In 1910 the return cargo received at Montreal by vessels bound for Fort William did not exceed 15 per cent of their capacity.[4] In 1920, 62 per cent of the steamers which went from Montreal through the St. Lawrence Canals moved in ballast. This lack of return cargo at Montreal is relatively important. The downbound cargo must stand the cost of the trip both ways, and the cost of the transfer at Montreal. Moreover, in navigating narrow channels large vessels are presumably at greater risk when in ballast than when loaded. The actual freight rates for shipment from the head of the Lakes by water are about the same whether or not the grain is transferred at Port Colborne. However, the profits from the section of the route below Port Colborne are smaller than those from the portion in the Upper Lakes because of the insurance on hulls. Ships in service between Fort William and Montreal pay from 1 to 2 per cent more insurance than those between Fort William and Port Colborne.[5] This is a recognition of the difficulties of navigating the Upper St. Lawrence.

The shipments of Canadian grain from the head of the lakes by continuous passage to Montreal have decreased notably since 1913. (Table II.) While this table includes only wheat, it is indica-

[4] *Canal Statistics*, 1910, Sessional Paper No. 20a, 1911, p. 12, Department of Railways and Canals, Ottawa.

[5] *Canal Statistics* 1912–16, Sessional Papers No. 20a, 1913–17 inclusive, Department of Railways and Canals, Ottawa.

tive of the movements of other grains during the same period. The shipments of wheat from Lake Superior ports through to Montreal by water averaged which furnish return cargo (Fig. 6). It has about the same rates on grain from Fort William as have Georgian Bay ports, although the difference in distance

TABLE II

Destination of Shipments of Canadian Wheat in Millions of Bushels by Lake-River from Fort William-Port Arthur, and Duluth-Superior for 1909 to 1922 inclusive.[7]

| *Year* | *Montreal* | *Georgian Bay Ports* | *Other (a) Canadian Lake Ports* | *Buffalo and other United States Lake Ports* | *Total* |
|---|---|---|---|---|---|
| 1909 | 11.0 | 13.4 | 10.2 | 12.4 | 47.0 |
| 1910 | 13.5 | 12.8 | 9.6 | 15.9 | 51.8 |
| 1911 | 12.7 | 10.3 | 11.8 | 28.6 | 63.6 |
| 1912 | 15.2 | 20.9 | 20.7 | 49.9 | 109.8 |
| 1913 | 15.2 | 26.1 | 28.9 | 71.5 | 141.7 |
| 1914 | 10.3 | 24.9 | 34.3 | 25.5 | 95.0 |
| 1915 | 4. | 25.3 | 33.1 | 107.7 | 170.1 |
| 1916 | 1.7 | 48. | 28. | 107.3 | 185.0 |
| 1917 | 1.3 | 52.5 | 31.4 | 73.5 | 158.6 |
| 1918 | .7 | 38.8 | 20.6 | 2.2 | 62.3 |
| 1919 | .6 | 53.8 | 33.1 | 4.1 | 91.6 |
| 1920 | .8 | 34.5 | 20.7 (b) | 53.8 | 109.9 |
| 1921 | .9 | 38.3 | 30.3 (c) | 83.9 | 153.5 |
| 1922 | 2.3 | 40.4 | 54.0 (d) | 128.6 | 225.4 |

(a) "Other Canadian Ports" practically means Port Colborne. About 90 per cent of the traffic is for Port Colborne which is chiefly a point of transhipment to Montreal.
(b) Includes 5, 337,000 bushels to Goderich.
(c) Includes 9,250,000 bushels to Goderich.
(d) Includes 15,116,000 bushels to Goderich.

13½ million bushels in the four-year period from 1909–13, 3.7 million bushels from 1914–18, and about one million bushels from 1919–22. This decrease has been due, in a large measure, to the great increase in the freight rates by the all-water route [6] and to the larger transhipment of grain at Port Colborne (Fig. 4). The increase in the amount transhipped there has been sufficient to offset the decrease in through movement, so that now, as in 1909–13, about one-third of the grain which reaches Montreal comes in by the water route.

Port Colborne's location makes it a very suitable point for the transfer of grain from the large lake vessels to those which can navigate the present Welland and the St. Lawrence Canals. It is near Buffalo, Erie, and Cleveland, places is 337 miles; frequently the rates to Port Colborne are lower than those to Georgian Bay ports, especially during the months and years when there is a large movement of grain.

A number of factors prevents a larger movement of grain by the all water route to Montreal. Three of these—(1) the slow, narrow, and shallow waterway between Port Colborne and Montreal (Fig. 7), (2) the lack of return cargo at Montreal, and (3) the additional insurance on ships which proceed down the St. Lawrence—have been discussed. (4) In addition, marine insurance rates are important. Rates on grain direct to Montreal from the head of the lakes are thirty cents per $100 higher than those to Georgian Bay ports and Port Colborne during April to October inclusive, and

[6] *Canal Statistics*, Sessional Papers, No. 20a, 1912 to 1922 inclusive, Department of Railways and Canals, and *The Grain Trade of Canada*, 1921–22, pp. 174, 183, Dominion Bureau of Statistics, Internal Trade Branch.

[7] *Canal Statistics*, Sessional Papers, No. 20a, 1914, p. 12, & No. 20a, 1921, p. 13. Department of Railways and Canals; and *The Grain Trade of Canada*, 1921–22, p. 79, Dominion Bureau of Statistics, Internal Trade Branch.

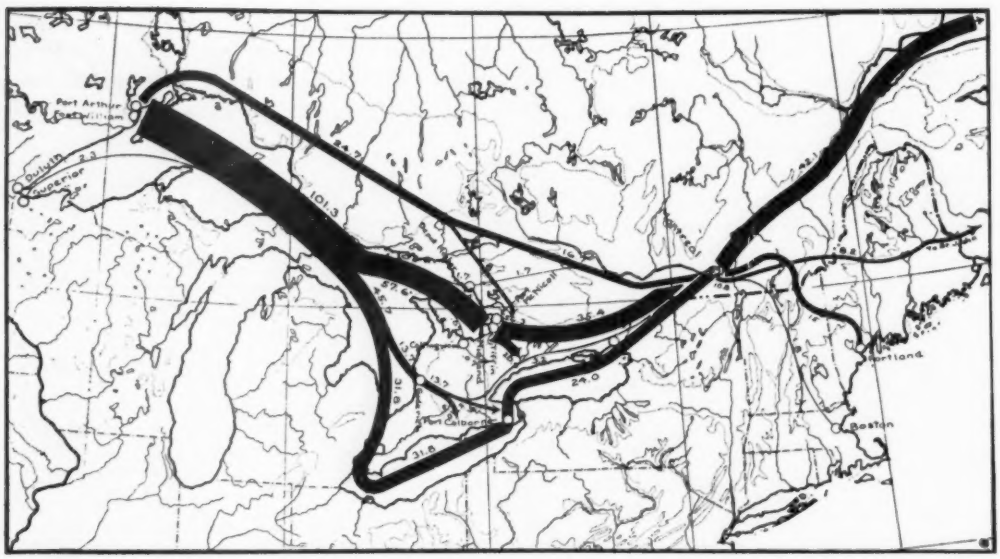


FIGURE 4.—The Movement of Canadian Grain in Millions of Bushels by Water, by Rail, and by Water-Rail, from Fort William-Port Arthur and Duluth-Superior to Canadian Lake and River Ports and also from Montreal via the Lower St. Lawrence and Atlantic Ports.

The figures are averages of four years. They are compiled from *The Grain Trade of Canada* for the crop years 1918–19 to 1922–23, Dominion Bureau of Statistics, Internal Trade Branch; Annual Reports of the Duluth Board of Trade, 1911 to 1922 inclusive; Statistical Reports of the New York Produce Exchange, 1917 to 1922 inclusive.

thirty-five cents higher during November.[8] These constitute a disadvantage to the all water route. (5) The season of navigation to Georgian Bay ports is about ten days longer than that to Montreal (Fig. 8). The season opens on the average from four to five days earlier than the St. Lawrence Canals and stays open five to six days longer. However, variations from the average are considerable. In 1920 the Sault Ste. Marie Canals remained open until December 22, eleven days later than the St. Lawrence Canals (Lachine). The difference in the length of the season at Sault Ste. Marie and on the St. Lawrence Canals shows an adjustment to the natural conditions of the route, which need not be discussed at this point.[9] The fact alone is of immediate significance in relation to the flow of grain via Georgian Bay Ports or the all water route to Montreal.

For example, in December, 1920, when the Sault Ste. Marie Canals remained open eleven days longer than the St. Lawrence Canals, 11.7 million bushels of Canadian grain moved to Georgian Bay ports and Goderich, while only 330,000 bushels were shipped by water to Montreal.[10] During the same month 17.5

[8] *Canal Statistics*, 1914, Sessional Paper, No 20a, 1915, p. 32. Department of Railways and Canals, and *The Grain Trade of Canada*, 1921–22, p. 183, Dominion Bureau of Statistics, Internal Trade Branch.

[9] A number of conditions account for the closing of the St. Lawrence Canals before the Sault Ste. Marie Canals. In the first place, the Sault Ste. Marie Canals are deeper and wider, giving a larger volume of water than in the St. Lawrence Canals. In the second place, the former are only 1.4 miles long and have five locks each, while the Lachine and Soulanges Canals are 8½ and 14 miles long, respectively. In the third place, there is a considerable current through the St. Mary's River and this with the short distance aids in keeping the canals open longer than those on the Upper St. Lawrence. In the fourth place, large numbers of vessels are using the Sault Ste. Marie Canals up to the end of the season, while only a few boats pass through the St. Lawrence Canals after December 7, the average date for the closing of the route. *Canal Statistics*, 1921, Sessional Paper No. 20a, 1922, p. 7; *The Great Lakes Pilot*, Volume I, 1921, pp. 699–727, Hydrographic Office, Washington.

[10] *The Grain Trade of Canada* for the crop year 1920–1921, pp. 90–1, Dominion Bureau of Statistics, Internal Trade Branch.

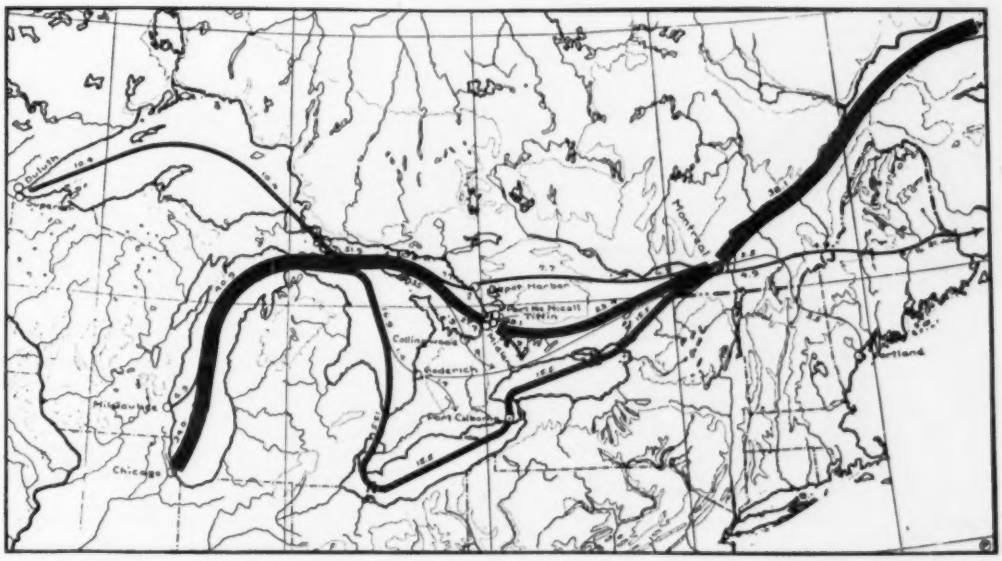


FIGURE 5.—The Movement of United States Grain in Millions of Bushels by Water, by Rail, by Water-Rail, from Chicago, Milwaukee, Duluth-Superior, to Canadian Lake and River Ports, and also from Montreal via the Lower St. Lawrence and Atlantic Ports.

The figures are averages of five years, 1917 to 1922. They are compiled from (1) Annual Report of the Duluth Board of Trade 1916 to 1919 inclusive, (2) Annual Report of the Milwaukee Chamber of Commerce, 1917 to 1920 inclusive, (3) Annual Report of the Chicago Board of Trade, 1917 to 1922 inclusive, (4) Annual Report of the Montreal Board of Trade, 1917 to 1922 inclusive, (5) The Grain Trade of Canada for the Crop Years, 1918–19 to 1922–23 inclusive, Dominion Bureau of Statistics, Internal Trade Branch.

million bushels of Canadian grain went to Buffalo and other United States Lake Erie Ports, while only 1.5 million bushels moved to Port Colborne, which serves chiefly as a transhipment point to Montreal by water. A similar condition prevailed in December, 1921, except that the St. Lawrence Canals remained open until December 14, seven days longer than the average; yet no more grain was transported to Montreal than when the St. Lawrence Canals closed on about the average date.[11] This means that practically no grain is routed via the all water route to Montreal after the first week in December, because shippers will not chance getting a cargo of grain caught in the ice on the Upper St. Lawrence Route.

With shipments to Georgian Bay Ports, the case is different because the restricted waterway at St. Mary's river is only about one-sixth as long as that on the Upper St. Lawrence. Moreover, at Sault Ste. Marie two canals are available for vessels and in St. Mary's river below the Canals a number of channels may be used. The great movement of grain at this time of the year emphasizes the importance of these factors in relation to the flow of grain by the all water route (Fig. 9).

The all water route handles thirty-four per cent of the United States grain which reaches Montreal from the head of the lakes. Most of this is transhipped at Port Colborne.

*The Lake and Rail Routes.* The lake and rail routes include lake lines from Chicago, Milwaukee, Duluth-Superior, and Fort William-Port Arthur to Georgian Bay ports and Goderich and railways from there to Montreal (Figs. 4 and 5). Fifty per cent of the Canadian grain and sixty-six per cent of the United States grain which goes to Montreal from

[11] *Canal Statistics*, Sessional Paper No. 20a, 1916, pp. 18–20, 26, 27; *The Grain Trade of Canada*, 1921–1922; pp. 100–1, Dominion Bureau of Statistics, Internal Trade Branch.

FIGURE 6.—Port Colborne, Maple Leaf Milling Company Government Grain Elevator. This is an important transfer point for grain en route to Montreal since the large lake vessels cannot proceed down the St. Lawrence canals. (Photo by Canadian Pacific Railway Company.)

the head of the Great Lakes moves by the lake and rail routes. While the all water route has barely been able to hold its own in the movement of grain to Montreal, shipments via Georgian Bay ports have increased about 300 per cent in the last ten years. A number of factors account for the relative importance of these routes.

The average freight rates on grain by the water-rail routes to Montreal are about two cents per bushel higher than those by all water; but the rates via water and rail include elevation and delivery charges at Georgian Bay ports and Montreal, and a maximum of fifty days' free storage at the former. These advantages of the lake and rail route are worth one and one-fourth cents per bushel to the exporter, because elevation from vessel to elevator and delivery to ocean steamer, including twenty days' storage, would cost three-quarters of a cent per bushel at Montreal.[12] This makes the all water route but little, if any cheaper, than the lake and rail haul.

The combination route is 300 miles shorter than the all water haul and the rail part covers one-third of the distance. The railways run special grain trains of cars with 2,000 bushels capacity between the lake ports and Montreal during the period of heavy traffic. The turnover of grain on the lake and rail route, therefore, is much quicker than on the all water haul. This fact assumes major importance in the movement of Canadian grain, because of its concentration in a few months during the autumn before the lakes are closed by ice (Table III). This table includes wheat only, but the move-

[12] *By-Laws of the Corporation of the Harbor Commissioners of Montreal, 1918*, p. 30, and 1922, p. 9.

FIGURE 7.—A Boat Loaded with Grain going down the Lachine Canal to the Port of Montreal. (Photo by C. F. Jones.)

Bay ports remains open a few days longer than the St. Lawrence Canals during this period of heavy traffic, these ports get a large amount of grain after the river closes. At this time considerable quantities of grain are rushed to the ports on Georgian Bay and to Buffalo for storage during the winter. The elevators on Georgian Bay afford the cheapest winter storage in Canada (Fig. 10). The grain from Georgian Bay ports and Buffalo is shipped on to Atlantic ports for

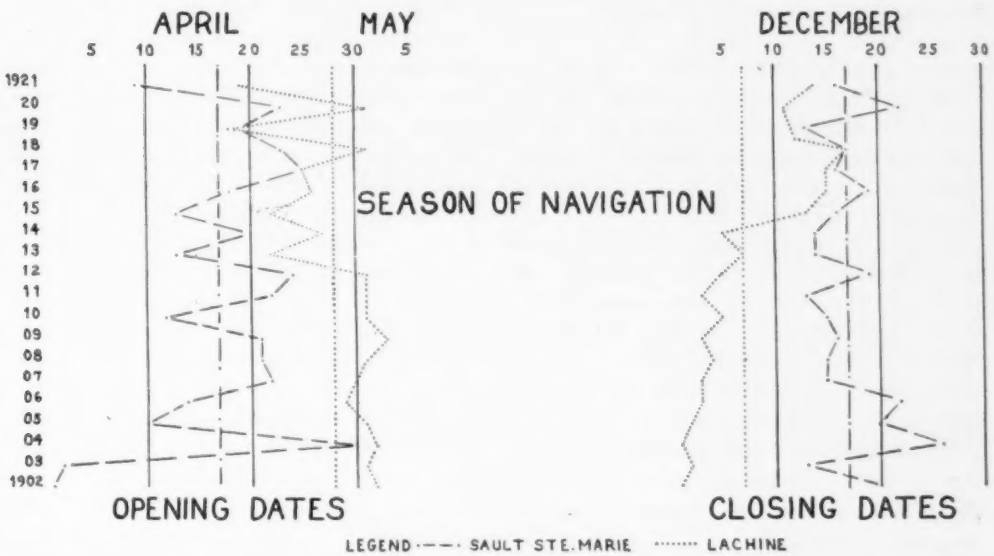


FIGURE 8.—A graph showing the opening dates, closing dates, and the average for the Sault Ste. Marie and the St. Lawrence Canals (Lachine) for 1902 to 1921.[13]

ment of other grains is concentrated similarly. From 1913 to 1921 inclusive an average of 65.6 per cent of the Canadian wheat shipped through the Sault Ste. Marie Canals moved during September, October, November, and December. The demand for rapid delivery at this period becomes a factor which exerts more influence on the movement of grain by these routes than the slight difference existing in freight rates between the lake and rail haul and all water carriage.

Since the waterway to the Georgian

[13] The dates for the graph were compiled from the Annual Reports of the Dept. of Railways and Canals, Sessional Papers, No. 20, 1904 to 1920, and Sessional Papers No. 32, 1922.

FIGURE 9.—The Sault Ste. Marie Locks. Since the Sault Ste. Marie Canals remain open longer than the St. Lawrence route, a large amount of grain moves to Georgian Bay Ports after the St. Lawrence is closed. (Photo Natural Resources Intelligence Service, Canada.)

FIGURE 10.—Midland, Ontario, one of the large Georgian Bay grain ports. (Photo Natural Resources Intelligence Service, Canada.)

export during the winter. All these factors, which represent definite adjustments to the physical environment in this region, cause more grain to flow to Montreal by the lake and rail routes than by the all water route.

The movement of United States grain through Georgian Bay ports accords well with the flow of Canadian grain. Eighty per cent of the United States grain which goes via the lake and rail routes moves during June to September inclusive,[14] when the amount of Canadian grain moving is small and before the autumn flow from Fort William and Port Arthur gets under way.

There are six lake and rail routes from the head of the Great Lakes to Montreal. Five of these are via Georgian Bay ports and the sixth via Goderich. The Georgian Bay ports include Depot Harbor, Port McNicoll, Tiffin, Midland, and Collingwood (Fig. 4). The more important of these are Port McNicoll, Tiffin, and Midland which are only a few miles apart. They provide the shortest rail haul to Montreal and the water route from Fort William and Port Arthur is but little longer than that to Depot Harbor or Collingwood. They have eighty per cent of the combined elevator capacity of the Georgian Bay ports. Moreover, they handle about ninety-five per cent of the Canadian and seventy-eight per cent of the United States grain which goes through the Georgian Bay ports. Apparently the tendency with reference to the lake and rail haul is to concentrate the trade along a few clearly defined routes rather than scatter it among many small ones (Figs. 4 and 5).

*The All Rail Routes.* The all rail routes for the shipment of grain to Montreal from the head of the Great Lakes include the Canadian Pacific and Canadian Northern railways (chiefly the Canadian Pacific), from Fort William and Port Arthur and the Michigan Central, Canadian Pacific, and the Grand Trunk Railways from Chicago.[16] About nineteen per cent of

TABLE III

The Movement of Canadian Wheat through the Sault Ste. Marie Canals according to the Percentages which moved each month during 1913–1921, inclusive.[15]

| *Month* | *1913* | *1914* | *1915* | *1916* | *1917* | *1918* | *1919* | *1920* | *1921* |
|---|---|---|---|---|---|---|---|---|---|
| April | 9.2 | 6.3 | 4.8 | 8.6 | .... | 7.1 | 9.6 | 3.4 | 4.6 |
| May | 11.7 | 19.5 | 5.5 | 16.9 | 19.2 | 4.1 | 22.8 | 9.0 | 6.6 |
| June | 6.0 | 7.9 | 2.0 | 11.9 | 14.5 | 6.5 | 5.6 | 2.9 | 5.2 |
| July | 4.4 | 7.4 | 1.9 | 14.4 | 6.1 | 1.8 | 2.3 | 4.7 | 3.5 |
| August | 2.6 | 2.3 | 1.3 | 11.8 | 5.2 | .8 | 1.3 | 5.5 | 3.5 |
| September | 6.9 | 13.8 | 7.3 | 6.1 | 4.1 | 1.9 | 11.0 | 5.8 | 10.5 |
| October | 26.1 | 19.5 | 27.5 | 8.7 | 19.6 | 18.3 | 23.0 | 20.6 | 22.0 |
| November | 22.6 | 17.6 | 29.7 | 12.0 | 21.6 | 43.1 | 16.4 | 27.4 | 30.0 |
| December | 10.2 | 5.7 | 20.0 | 9.6 | 9.7 | 16.4 | 8.0 | 20.7 | 14.1 |

[14] *The Grain Trade of Canada* for the crop years 1919–20, 1920–21, 1921–22, pp. 67, 99, and 109 respectively, Dominion Bureau of Statistics, Internal Trade Branch.

[15] Compiled from *Canal Statistics* 1916 to 1921, Sessional Papers No. 20a, 1917, to 1922 inclusive, Department of Railways and Canals, Ottawa.

[16] It has not been possible to get the exact shipments of grain from Chicago to Canada by rail, but some grain moves that way for consumption in Canada (corn and oats) and possibly for export through Montreal or Portland. Sessional Paper No. 20, 1922, p. 181, *Department of Railways and Canals*, Ottawa; and *Annual Report of the Chicago Board of Trade*, 1922, p.

the Canadian grain which reaches Montreal is transported by all rail from Fort William and Port Arthur. Most of the grain shipped by rail from Fort William moves during the winter to Eastern Canada for consumption or through Montreal for export via St. John or United States ports. This represents a definite adjustment to the closing of navigation on the Great Lakes in the winter. The all rail route cannot compete with the all water or with the water and rail route. The haul by the Canadian Pacific and the Canadian Northern Railways from Fort William and Port Arthur is long and expensive, and only an active demand and a high price for grain in Eastern Canada or Europe causes any considerable amount of grain to move via the all rail route.

The flow of United States grain through Montreal fluctuates greatly from year to year. 1918, 1921, and 1922 were years of large shipments, while small quantities moved during 1917, 1919, and 1920. For 1918 the average freight rates by lake and rail from Chicago to Montreal via Georgian Bay ports were three and two-third cents per bushel less on wheat and corn than the corresponding rates from Chicago to New York via Buffalo. These same rates to Montreal were three cents less than the all water route to New York.[17]

In response to these conditions more grain moved from Chicago to Canadian ports than to United States ports.[18] Furthermore, most of the United States grain went during June to September inclusive, when very little Canadian grain was being shipped. Therefore, the shippers, who later in the season might be engaged in transporting Canadian grain could afford to cut the rates in order to get cargo. In addition, at this time the port of New York was congested and exported less grain than normally.

The situation in 1921 and 1922, other years of heavy movement of United States grain through Montreal, was somewhat different from that in 1918. In 1921 practically all of the grain moved consisted of corn and oats. The rates on corn averaged one and one-half cents cheaper by lake and rail from Chicago to Montreal than to New York, and by the all water route nearly three cents less. A third of the grain which went to Montreal moved by the all water route. This difference in rates operated in favor of the Canadian routes because of a very large flow of grain to United States ports via the lake and rail haul. The conditions in 1922 were similar to those of the preceding year, except for a larger movement of wheat during the latter. When there is a large amount of grain for export from the United States, Montreal may get a great deal with freight rates only slightly lower from the interior than those to New York. Other factors, such as the cost of transfer at the seaboard, availability of ocean tonnage, and ocean freight rates, influence this movement. These will be discussed subsequently.

## THE FACILITIES FOR HANDLING, THE METHOD OF HANDLING, AND THE COST OF TRANSFER OF GRAIN IN MONTREAL

The facilities for receiving grain from the railways and canal boats and for its transfer to ocean-going vessels are important factors in making Montreal a great grain port. There are three huge elevators (Fig. 11) with a combined storage capacity of 9,000,000 bushels in the central part of the port.[19] The harbor belt railway line runs alongside each elevator so that cars coming in on any railway may be switched directly to any of the three elevators (Fig. 12).

3. Montreal has the same rail freight rate on grain for export from Chicago as that of Philadelphia, which is one cent per hundred pounds less than that to New York.

[17] *Annual Report of the Chicago Board of Trade*, 1917, to 1922, inclusive: *The Grain Trade of Canada*, 1921–22, p. 174, Dominion Bureau of Statistics, Internal Trade Branch.

[18] *Loc. cit.*

[19] *The Grain Trade of Canada*, 1921–22, p. 96, Dominion Bureau of Statistics, Internal Trade Branch.

This aspect of the port of Montreal is different from that in most other ports in North America, for in those the elevators are owned and operated in most instances by various railways.

In the port of Montreal it is important that the railway cars be delivered to the elevators and the grain unloaded without delay, especially during the autumn. The lake boats and river barges too must be relieved of their cargo and dispatched without delay because of the heavy flow of grain through the port at this critical period (Fig. 13).

Grain from lake vessels and river barges is received directly into the elevators which unload grain at the same time from railway cars. Elevator No. 1 can unload thirty-six cars per hour (about 50,000 bushels), and the other two about the same. Elevators No. 1 and 2 are connected with each other and with the twenty steamship berths in the central part of the port by long tunnel-like grain conveyor galleries, and each can deliver grain to all the berths in this part of the harbor (Figs. 14–15). The three elevators have a delivery capacity of 190,000 bushels per hour. Moreover, line steamers at any of the berths can load grain and general cargo simultaneously, an important item in the economy of time. Speed in the transfer of grain at the port of Montreal is essential if it is to function effectively in the great movement of Canadian grain during the later part of the season of navigation.

FIGURE 11.—The Port of Montreal. Elevators No. 1 and 2, with the grain conveyor gallery and sheds stand out in the middle distance. The grain conveyor of the third elevator is shown in the lower right hand corner of the picture. (Photo by C. F. Jones.)

The degree to which speed has been

developed may be illustrated by two examples. On August 27, 1922, a steamer in eleven hours loaded her cargo of 240,000 bushels of grain, establishing a record for speed in loading. On October 13, 1922, the three elevators in the port received from lake vessels and railway cars 892,000 bushels of grain and delivered to ocean steamers, 1,428,000 bushels.[20] The grain received at the port on that day was equal to sixteen and one-half trains of forty cars each and that delivered to ocean steamers, twenty-six and one-half trains of the same length. This gives a concrete idea of the enormous traffic in grain through Montreal during the autumn to which the activities of the port machine must be adapted.

The small charge for handling grain at Montreal stimulates the movement through the port. The cost of elevating, weighing, twenty days' storage, and delivery to ocean steamers amounts to three-fifths of a cent per bushel on grain from lake vessel or barge and nine-tenths of a cent on that from railway cars.[21]

The significance of these grain handling facilities and the cost of the transfer of grain at Montreal is demonstrated by a comparison of the conditions at the port of New York, which competes with Montreal for both United States and Canadian grain and possesses certain distinct advantages.

The port of New York has six elevators with a combined storage capacity

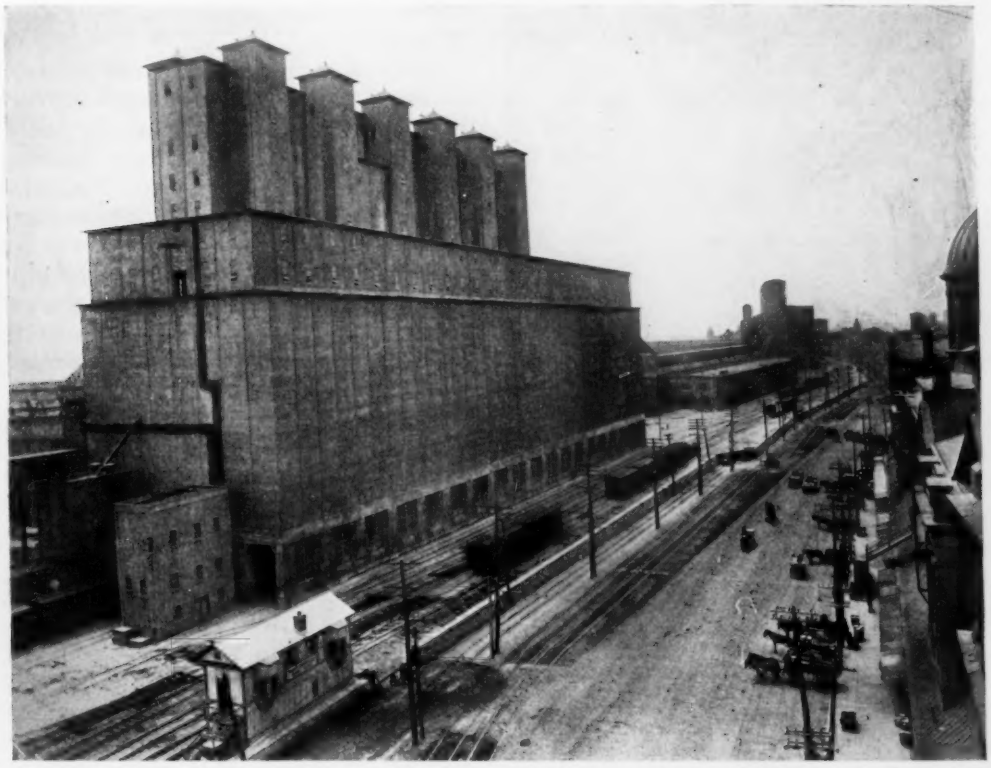

FIGURE 12.—Commissioners Street, Overseas Terminals, and Grain Elevators and Conveyors, Montreal. The harbor belt railway extends alongside each elevator, making possible the rapid delivery of railway cars to the elevators. (Photo by Canadian Pacific Railway Company.)

[20] *Annual report of the Board of Harbor Commissioners of Montreal*, 1922, p. 30.

[21] *By-Laws of the Harbor Commissioners of Montreal*, 1918, p. 30.

of 6,650,000 bushels,[22] 2,350,000 less than that of Montreal. These elevators are all owned by railroad corporations and located in different parts of the port. On the other hand, the elevators at Montreal are concentrated in a little over a mile of river front where the great steamship terminals are situated. Only three of the New York elevators can deliver directly to ocean ships, two at Weehawken and one at Jersey City. Their delivery capacity is about 39,000 bushels per hour. Little grain, however, is delivered directly to ocean liners. Most of it is unloaded from the railroad elevators to lighters which belong, for the most part, to the different railroads. The lighters then are towed across the harbor to the docks where the ocean

FIGURE 13.—The Lower End of the Lachine Canal during the heavy movement of grain in the autumn. (Picture taken September 8, 1922.) (Photo by C. F. Jones.)

steamer is loading. The grain is transferred from the lighters to the vessel by floating elevators. This indirect method consumes considerable time, especially when there exists a shortage of barge service, as frequently happens.

Delays because of the indirect method of handling at New York mean much to the shipper. For example, in 1920 shippers could get eleven cents a bushel more for wheat put on board vessel than if it were merely delivered at the railway elevators.[23] Loading direct from elevator to ship, without the intermediate barge and floating elevator certainly is the cheapest means of transfer. It is feasible at Montreal, where the terminal layout is concentrated and centralized in a short distance, to serve the principal general cargo piers by means of grain conveyor galleries (Fig. 11). This would not be possible in New York as the terminals are distributed over many miles of waterfront.

The cost of transferring grain from elevator to ship in the port of New York consists of one-half of a cent per bushel for barge service, seven-eighths of a cent for floating elevator service, and one-eighth of a cent for moving the elevator —a total of one and one-half cents per bushel. In Montreal to get a bushel of grain from a railway car, a lake vessel, or a river barge, through the elevator to the ocean steamer, costs less than one cent per bushel.

Montreal, therefore, has notable advantages over New York for the transfer of grain quickly and cheaply.

The development of these grain handling facilities has been an adaptation to the large amount of grain moving during the Autumn. Only a few years ago most of the grain at Montreal was transferred from lake vessel or river barge to ocean steamer by floating elevators, a relatively slow process. The heavy autumn flow of grain necessitated rapid transfer and despatch. Therefore, large modern elevators with conveyor galleries were constructed and a most efficient system developed to use them. During the season of heavy traffic, the elevators work day and night for seven days a week. These represent adjustments to the short season of navigation after the Canadian crop of grain begins to move.

Other adaptations have been made to this concentration of grain movement in a few months of the shipping season. A

[22] This does not include five private elevators (capacity 580,000 bushels) which are used for local distribution, in the city and not for export movement. *Joint Report of the New York-New Jersey Port and Harbor Development Commission* (Albany, 1928), pp. 408–19.

[23] *The St. Lawrence Waterway*, Senate Document 114, 67th Congress, Second Session, p. 73.

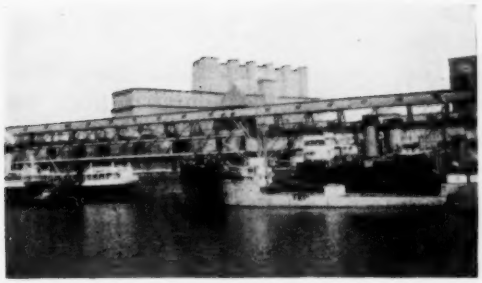

FIGURE 14.—Jacques Cartier Pier, with transit sheds and grain conveyor gallery, Montreal. The boats are loading grain from the spouts. Elevator No. 1 is in the distance. (Photo by C. F. Jones.)

"Grain Clearance Board" of four men has control of the whole grain movement through the port. These men gather complete information on the flow of export grain to and through Montreal, and on the basis of this information prevent congestion and unnecessary delays in receiving and delivering grain, and keep, on the whole, the facilities of the port machine working at a high degree of efficiency, thus augmenting the importance of Montreal as a grain port.

### THE INFLUENCE OF AVAILABLE OCEAN TONNAGE, OCEAN FREIGHT RATES, AND INSURANCE RATES ON THE MOVEMENT OF GRAIN THROUGH THE PORT

The availability of ocean tonnage at a seaport and the freight rates and insurance rates on the cargo from that port to the overseas markets may exert as much influence on the flow of grain from the port as the facilities for bringing it to the port and for transferring it there. From 1900 to 1923 New York exported more grain than Montreal, except for six years (Fig. 16). It must be kept in mind that this means twelve months of operation at New York and seven at Montreal.

Grain may be exported as part cargo on liners carrying general freight, or as entire cargo on tramp vessels. Until recently nearly all the grain exported from Montreal and New York was shipped as part cargo on freight liners. As long as this prevailed New York had a distinct advantage over Montreal, because of greater liner service.

Before the war the certainty of securing space at New York during the heavy flow of grain in the late summer in many instances led dealers at Winnipeg and Chicago to ship grain via New York even though the rates to Montreal were cheaper than those to New York.[24]

At present, the situation is different. Liner services at Montreal have increased greatly, so that this port now has rather frequent and direct freight liner services to all the principal ports of Europe. Of course, New York has much greater liner service, but a large number of the new liners running from New York do not carry grain, and the ordinary liners are taking about all the grain they can handle.[25]

Recently tramps have been coming to both New York and Montreal for grain. In 1922, 342 vessels loaded full cargoes of grain at Montreal. At the present time, Montreal has shipping space available for grain practically equal to that of New York. However, it must be noted that tramp vessels do not come to Montreal after the latter part of October because they will not take chances of being caught there during the winter or run the danger of trouble with ice near the close of the season.

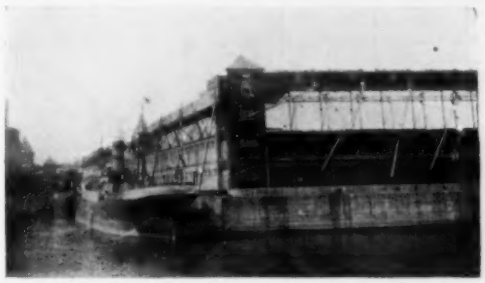

FIGURE 15.—The Elbow of Victoria Pier, Montreal. The "*Comino*" of London loading grain from the conveyor, which is connected with elevator No. 2 in extreme left of picture. (Photo by C. F. Jones.)

[24] *Canal Statistics 1913*, Sessional Paper No. 20a, 1914, p. 13, Department of Railways and Canals, Ottawa.

[25] *Joint Report of the New York, New Jersey Port and Harbor Development Commission* (Albany, 1920), pp. 408–419.

The ocean freight rates on grain out of Montreal during May to November, the season of navigation on the St. Lawrence, average from three-fourths to one and two-tenths cents per bushel higher than those from New York during the same time.[26] Freight rates vary considerably from the average in short intervals of time. Comparatively few ocean carriers engaged in international trade print their tariffs. No tariffs of charter rates are published, charter rates always being matters of individual bargaining.

Carriers operating line vessels feel free to vary their rates at will, either by individual action or in conference with rivals, and to make such contracts with shippers, as may seem best in view of the momentary conditions of competition or of the conference agreements which they may have promised to observe. Therefore, it is impossible to base the discussion at this point on precise statistical information. It may be

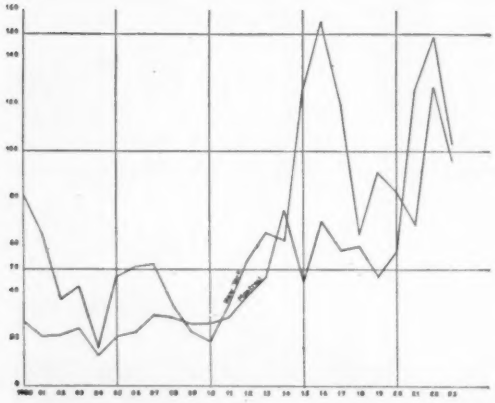

FIGURE 16.—The Exports of Canadian and United States Grain from Montreal and New York by years from 1900 to 1923.

concluded, however, from the data at hand, that New York, in so far as ocean freight rates are concerned, has a distinct advantage over Montreal for the exportation of grain.

The insurance rates on grain from Montreal to United Kingdom ports are higher than those from New York, as is shown by the accompanying Table IV.

In 1910 and 1911 the insurance on grain from Montreal between the opening of navigation and September 15 was about one-fifth of a cent per bushel greater than from New York. In 1921 from Montreal during the same period they were two-fifths of a cent per bushel more than those from New York. While the rates per $100 may remain the same, the amount paid by the shipper may vary considerably due to the difference in the price of wheat. The difference here noted between the insurance rates from Montreal and New York is small, yet it may be sufficiently great to cause the shipper to choose the cheaper route.[27] New York, therefore, has a slight advantage over Montreal from this standpoint during the major portion of the navigation season on the St. Lawrence and a notable advantage from September 16 until the close of the season, because of the increase in the rates on the St. Lawrence Route after that date, owing to the hazards to shipping on the restricted St. Lawrence Channel.

In the preceding sections the routes for the shipment of grain to Montreal, the facilities and methods of handling grain there, and the factors influencing its shipment from the port to the markets overseas have been analyzed separately. It is necessary now to bring these together to show the relation of the flow of grain to the through costs of shipment. The through costs, after all, and the dispatch with which the grain may be delivered are the things which determine the route that grain takes from the interior points of concentration to the markets overseas. A comparison of Montreal with New York brings out the

[26] *Canal Statistics, 1910*, Sessional Paper No. 20a, 1911, pp. 11–12, Department of Railways and Canals, Ottawa; *Statistical Report of the New York Produce Exchange* for 1912, 1913, 1920, and 1921; *The Grain Trade on Canada* for the crop year 1921–22, p. 184, Dominion Bureau of Statistics, Internal Trade Branch.

[27] MacElwee and Ritter, *Economic Aspects of the Great Lakes-St. Lawrence Ship Canal* (New York, 1921), pp. 253, 262–3.

advantages and the disadvantages of the Montreal route.

Figure 16 shows the shipment of Canadian and United States grain from Montreal and New York since 1900. The exports by Montreal averaged five million bushels less than those by New York from 1910 to 1914. From the standpoint of through transportation costs, the difference was not great enough at this time to give either port any decided advantage over the other, as is shown by the accompanying Table V.

The table includes costs for only one season, but they are representative of the period 1910 to 1914. New York's chief advantage then lay in its preponderance of established transoceanic lines, whose ships carried grain as supplementary cargo. It must be remembered that the season at Montreal includes seven months and that at New York twelve. Moreover, a relatively large part of the Canadian grain which went through New York from 1910–1914 moved during the winter.

The situation in 1915 to 1917 inclusive was different. New York exported an average of 76.1 million bushels more grain than Montreal. During these years, both the United States and Canada exported unusually large amounts of grain. Moreover, at this time troops and war supplies were moving through Montreal. Therefore, a large trade naturally flowed through New York.

In seven months of operation during 1921, Montreal exported 57.3 million bushels more grain than New York did in twelve months. The through transportation costs gave neither port the advantage. The considerably higher ocean freight rates from Montreal were offset by the marked lower lake and rail rates to Montreal. The uncertainty of delivery to ocean steamers at New York owing to the barge floating elevator

TABLE IV

Insurance Rates on Grain in Cents per $100 from Montreal and New York to United Kingdom Ports.[28]

| *Montreal* | *1910* | *1911* | *1920* | *1921* |
|---|---|---|---|---|
| 1. May 1 to September 15 | 25 | 25 | 25 | 25 |
| 2. September 16 to October 15 | 35 | 35 | 27½ | 25 |
| 3. October 16 to October 31 | 45 | 45 | 32½ | 30 |
| 4. November 1 to November 15 | 60 | 65 | 42½ | 40 |
| 5. November 16 to November 30 | 75 | 110 | 55 | 52½ |
| *New York* | | | | |
| Throughout the year | 12½–15(a) | 12½–15 | 12½–20 | 12½–20 |

(a) According to the class of steamer

TABLE V

Comparison of Approximate Total Transportation Charges on Wheat from Chicago to London by Various Routes in Cents per Bushel during Seven months of 1913.[29]

| *Route* | *May* | *June* | *July* | *August* | *September* | *October* | *November* |
|---|---|---|---|---|---|---|---|
| *Montreal* | | | | | | | |
| Liner | 15.00 | 14.42 | 14.00 | 13.55 | 13.12 | 13.54 | 14.05 |
| Tramp | 15.00 | 13.98 | 15.11 | 15.36 | 15.36 | .... | ..... |
| *New York* | | | | | | | |
| Liner | 15.45 | 13.96 | 13.36 | 13.11 | 12.99 | 13.11 | 11.61 |
| Tramp | 16.85 | ..... | 14.29 | 16.08 | 16.09 | 15.28 | 14.46 |

[28] Compiled from:

*The Grain Trade of Canada* for the crop year 1921–22, p. 185, Dominion Bureau of Statistics, Internal Trade Branch.

*Canal Statistics*, 1914, Sessional Paper No. 20a, 1911, pp. 11–12, Department of Railways and Canals.

*Canal Statistics, 1911*, Sessional Paper No. 20a, 1912, p. 11, Department of Railways and Canals.

*The St. Lawrence Waterway*, Senate Document, No. 114, 67 Congress, Second Session, pp. 57, 64–5.

[29] *Joint Report of the New York, New Jersey Port and Harbor Development Commission* (Albany, 1920), p. 419.

method of transferring grain and the consequent greater cost of transfer led to more grain moving through Montreal than New York. It is to be noted that 52 and 39 million bushels of Canadian grain moved through Montreal and New York respectively and 74 and 29.8 million bushels respectively of United States grain.

Canadian grain begins to move in large amounts through United States ports in November and through St. John in December,[30] thus reflecting the heavy shipping from ports at the head of the Great Lakes just before they are closed to navigation and before the closing of the port of Montreal in December (Fig. 17). This movement through United States ports and St. John continues until the opening of Navigation at Montreal in the latter part of April. Seventy-one per cent of the exports of Canadian grain through United States Atlantic ports goes during the closed season of navigation at Montreal and 11½ per cent during the month of November, leaving about 17 per cent for May to October inclusive. All the grain which is exported through St. John and Portland moves through Montreal from Georgian Bay ports and from Fort William and Port Arthur.

## CONCLUSION

The foregoing analysis of the grain trade of the port of Montreal leads to two groups of conclusions. The first group concerns the relation of Montreal to the grain trade of Canada and the United States with particular reference to the competitive ability of Montreal among the several Atlantic ports through which Canadian and United States grain is exported. The second group of conclusions has to do with the relation of the grain trade activities of the port of Montreal to the natural environment and represents, therefore, the essentials of a geographic interpretation.

[30] *The Grain Trade of Canada* for the crop year 1920–1921, pp. 90–1, 111–12; 1921–22, pp. 100–1, 131–2, Dominion Bureau of Statistics, Internal Trade Branch.

The relation of Montreal to the grain trade of Canada is:

(1) That from May to October inclusive, Montreal is able to handle nearly all of the oversea exports of Canadian grain.

(2) That, judging by the last four years, the port of Montreal is handling an appreciable portion and an increasing part of the total exports of United States grain.

(3) That Montreal has a port equipment for the handling of grain equal to and in many respects superior to that of the port of New York.

The facilities for the transportation of grain from the points of concentration at the head of the Great Lakes to Montreal are better than those of New York.

The corresponding inland freight rates by water, by rail, and by water-rail, are, on the average, considerably lower to Montreal than to New York.

The terminal facilities—the elevators, the grain conveyor galleries, the harbor belt railway, the concentrated and centralized terminals,—the method of handling the grain, and the cost of transferring grain from inland carriers to ocean vessels at Montreal are far superior to those at New York.

Moreover, Montreal has shipping space available for grain practically equal to that of New York, although until recently the latter had an advantage over the former in this respect.

On the other hand, while Montreal is at a disadvantage compared to New York with reference to ocean insurance and ocean freight rates on grain, it is concluded from the study that this handicap is more than offset by the advantage Montreal has in inland freight rates; and furthermore, the port administration at Montreal is much more effective in the movement of grain than that of New York.

(4) That Montreal is handicapped by the present size of the St. Lawrence canals which do not permit the larger lake vessels to come to the ocean port. For this reason, a more thorough organization

FIGURE 17.—West St. John, New Brunswick. This port is the chief Canadian outlet for grain during the winter, when the Port of Montreal is closed by ice. (Photo by Canadian Pacific Railway Company.)

of lake transportation to Montreal cannot be developed.

(5) That the closing of the St. Lawrence to navigation from December to May is the one great handicap to Montreal as a grain shipping port.

The relation of the grain trade activities of the port of Montreal to the natural environment is:

(1) In the first place, the flow of grain through Montreal is an adjustment to the location of the port,

(a) between the surplus grain producing areas of central North America, on the one hand, and industrial Europe on the other:

(b) at the head of ocean navigation on the St. Lawrence River;

(c) at the focal point for water routes, rail routes and water-rail routes from the head of the Great Lakes;

(d) at a point from which railway lines diverge to ports on the Atlantic.

(2) Nearly all the United States grain which moves through Montreal goes during June to August inclusive in adjustment to the somewhat earlier harvest in the United States than in Canada and to the slack movement of Canadian grain at this time.

(3) The heavy flow of Canadian grain through the port during September to November inclusive is a direct adjustment on the one hand to the rather late harvest in the Prairie Plains and on the other, to the fact that the St. Lawrence and Great Lakes close early in December. The shippers attempt to move as much of the crop as possible before the season of navigation closes.

(4) The closing of the St. Lawrence to navigation for five months of the year causes an almost complete reorganization of the grain trade of Montreal and of Canada. The flow of grain continues through the port in large volume until

the end of November; some moves out in December, immediately before the St. Lawrence closes, but few boats come to Montreal after November 25 because they will not take chances of being caught there during the winter. This condition requires the operation of a large additional amount of railway mileage and two sets of terminals and necessitates the shifting of all the ocean ships in the Montreal grain service to other ports which get the winter export grain.

(5) If the St. Lawrence were open throughout the year, it is probable that practically all the overseas shipments of Canadian grain and a large part of the exports of United States grain from the Corn and Winter Wheat Belt and the Spring Wheat Belt would move through the port of Montreal.

# THE COAL RESOURCES OF CANADA

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Natural Resources Intelligence Service of Canada

THE sight of long trains of coal laboriously wending their way northward from the Pennsylvania coal-fields to Canada would apparently justify one in the assumption that the northern neighbor of the United States is deficient in coal resources. Nothing, however, could be further from the truth. As a matter of fact, Canada has one-sixth of all the coal in the world—almost as much as the whole continent of Asia, more than Europe, Africa and Oceania, and over one and a half times as much as all the countries of Europe combined. Her coal reserves are second only to those of the United States. It cannot be gainsaid that when coal resources were being given out, nature dealt to her with lavish hand.

And yet Canada imports coal in large quantities. She is peculiarly dependent on the coal-fields of the United States for this commodity, so vital for domestic heating in a rigorous winter climate and so necessary for industrial development in any country. Why such an anomaly? Why these large imports when there are abundant supplies of coal at home? Canada imports three-fifths of the coal she consumes because her own deposits are located far away from the large coal-consuming centres of population. This great geographic fact lies at the root of what Canadians have come to call their "fuel problem." It is cheaper and more convenient to import coal from other countries than to pay for the long haul from their own coal-fields. Canada's fuel problem, in the final analysis, is, therefore, not one of supply but of distribution.

The significance of these facts cannot be fully appreciated unless we keep in mind several important geographic truths. First of all, it should be remembered that Canada is a very large country. The distance from Halifax on the Atlantic to Vancouver on the Pacific is 3,600 miles. Her principal coal-fields are in Nova Scotia and in Alberta and British Columbia, on the eastern and western extremities; whereas the manufacturing and commercial provinces of Ontario and Quebec, containing three-fifths of the population, are centrally located. Toronto, the capital of Ontario, is approximately 1000 miles from the Nova Scotia coal-fields and about 2,000 miles from those of Alberta. And as if this geographic handicap to national self-sufficiency in fuel were not enough, there has been added another. The Ontario peninsula, which is the most highly industrialized section of Canada, is thrust southward almost into the large coal-producing area of the United States, with which it is connected by numerous, well-organized and highly efficient lines of transportation.

Consequently, in the matter of freight rates, as in that of distance, coal shipped from the adjacent United States to the central provinces of Ontario and Quebec possesses a decided advantage over that from far-off Alberta and Nova Scotia. For instance, the freight rate on coal from Drumheller in Alberta to Toronto is $12.70 a ton for the 2,026-mile haul. For the 356-mile haul from Scranton, Pennsylvania, to Toronto, the rate is $3.96 for anthracite, and for the 290-mile haul from Clearfield, Pennsylvania, it is $3.09 for bituminous. The rate from Springhill, Nova Scotia, to Toronto is $6.50 all rail, for the 1,052-mile haul, and $4.75, water and rail, from Sydney. Rates to Montreal permit competition there between Nova Scotia and United States coals. It costs from $1.00 to $1.25 by water and $3.60 all rail (613

miles) to ship a ton of coal from Sydney, Nova Scotia, to Montreal. From Scranton to Montreal (396 miles) the rate on anthracite is $4.42, whilst the freight rate on bituminous from Clearfield, Pennsylvania (477 miles), is $4.00. It is not difficult to understand why a large and lucrative trade has been built up between the United States and central Canada in both anthracite and bituminous coal.

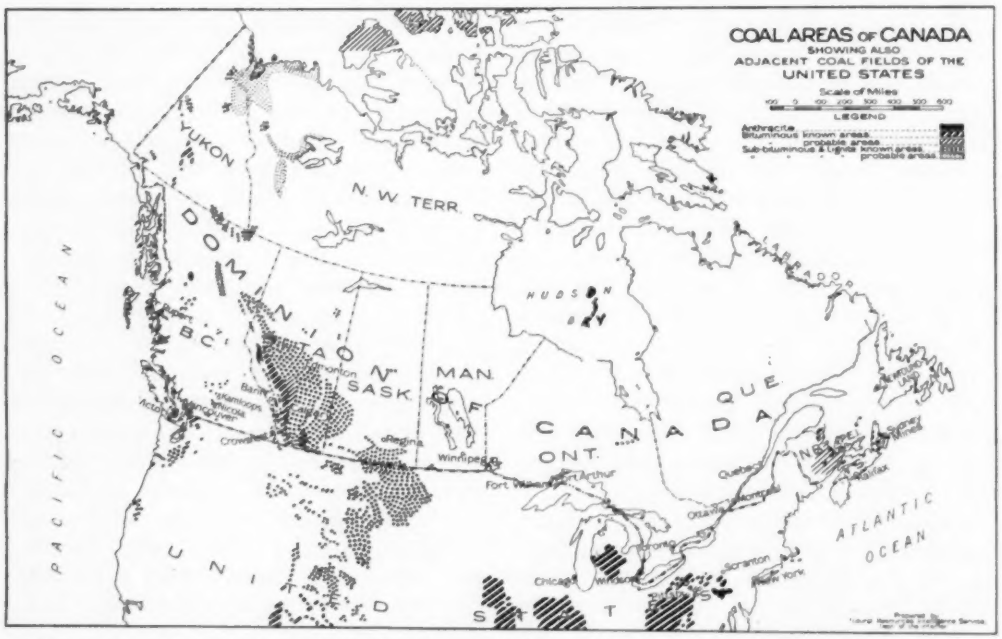


FIGURE 1.—Canada has one-sixth of all the coal in the world. Her reserves are second only to those of the United States. Her coal fields are distributed from the Pacific Coast to the Atlantic and from the Mackenzie Basin to the boundary of the United States.

I have emphasized the factor of long hauls and high freight rates due to populous, industrialized central Canada being far removed from the coal-fields of Nova Scotia, Alberta and British Columbia, because it is a basic one. Without a clear understanding of its influence, the significance and value of the coal-fields of Canada in providing the nation's fuel supply cannot be properly apprehended.

## CANADIAN COAL RESOURCES

Official estimates by the Geological Survey place the coal reserves of Canada at 1,229,236 million tons. This compares with 3,838,657 million tons for the United States, which has the largest reserves of any nation and is the only country whose reserves exceed those of Canada. Unlike the United States, however, Canada is deficient in anthracite, although, at the present time, small reserves of semi-anthracite are known to exist in Alberta and British Columbia.

Of bituminous and sub-bituminous coals, however, Canada has enormous reserves. These are located for the most part in the western interior, although there are important fields also on both coasts. On the Atlantic coast, bituminous coals are extensively mined for power production, manufacturing, and for railway and marine transportation purposes, as well as for the reduction of iron ore and for domestic heating. On the Pacific coast, bituminous coals are mined for power production, domestic heating, ship bunkering and for export. The interior of British Columbia produces coking coals, which are used to

some extent in the smelting of metal ores. With the exploitation of the abundant undeveloped mineral resources of the province, their use for metallurgical purposes is bound to increase.

The fields of the interior portion of Canada supply coals of various grades, and in Manitoba, coals of lignitic character are found in large supply. These are well adapted to local domestic use. The coals of the Arctic islands, located in a frigid and little frequented territory, are of no practical value at the present time. Little is known of either their extent or

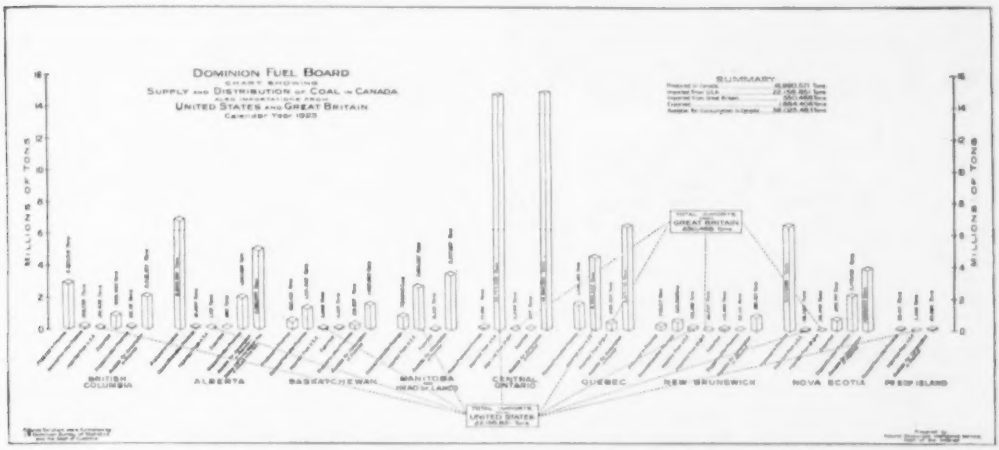


FIGURE 2.—Though Canada's coal deposits and reserves are large, she imports coal in large quantities from the United States, because her ore deposits are located far away from the large consuming centers of population. This great geographic fact constitutes the "fuel problem" of Canada.

those of the mountainous region of eastern British Columbia and western Alberta being the most important and of the highest grade. The extensive

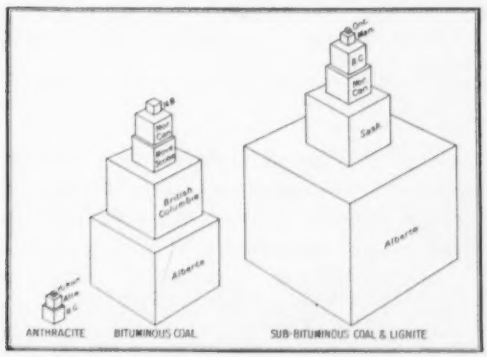


FIGURE 3.—This graph emphasizes the dominance of the western provinces in the distribution of Canada's coal resources. Alberta is the most favored of all the provinces.

coal-fields of Alberta, which contain coals of a wide range of character, form Canada's largest and most important coal reserve. In southern Saskatchewan

quality. It is, however, interesting to observe that they lie in about the same latitude as the Spitzbergen coals in Europe.

The accompanying table gives a

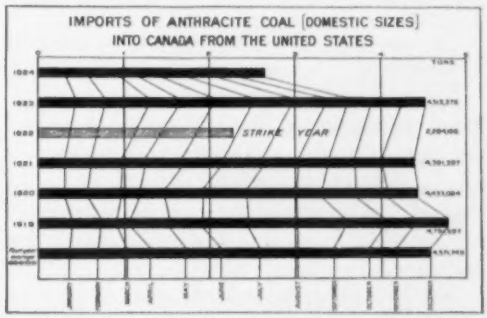


FIGURE 4.—Canada depends almost entirely upon the United States for her supply of anthracite coal. In normal years the quantity imported is rather uniform. By courtesy of the Dominion Fuel Board.

summary of the coal reserves of Canada by provinces as estimated by the Geological Survey of Canada. The actual

TABLE I

ESTIMATED COAL RESOURCES OF CANADA

*Group I. Including Seams of 1 Foot and Over, to a Depth of 4,000 Feet*

| | Actual Reserve (Based on actual thickness and extent) | | | Probable Reserves* | | |
|---|---|---|---|---|---|---|
| *District* | *Tons (Metric)* | *Class of Coal†* | *Area (Sq. Miles)* | *Tons (Metric)* | *Class of Coal†* | *Area (Sq. Miles)* |
| Nova Scotia | 2,137,736,000 | $B_2$ | 174.31 | 4,871,817,000 | $B_2$ | 273.5 |
| | 50,415,000 | C | | 20,000,000 | C | |
| New Brunswick | ..... | .. | .... | 151,000,000 | $B_2$ | 121.0 |
| Ontario | ..... | .. | .... | 25,000,000 | $D_2$ | 10.0 |
| Manitoba | ..... | .. | .... | 160,000,000 | $D_2$ | 48.0 |
| Saskatchewan | 2,412,000,000 | $D_2$ | 306.0 | 57,400,000,000 | $D_2$ | 13,100.0 |
| Alberta | ..... | $D_2$ | 25,300.0 | 26,450,000,000 | $D_2$ | 56,375.0 |
| | 382,500,000,000 | $D_1$ | | 464,821,000,000 | $D_1$ | |
| | 1,197,000,000 | $B_3$ | | 139,161,000,000 | $B_3$ | |
| | 2,026,800,000 | $B_2$ $B_1$ | | 43,022,600,000 | $B_2$ $B_1$ | |
| | 669,000,000 | $A_2$ | | 100,000,000 | $A_2$ | |
| British Columbia | 22,666,014,000 | $A_2$ $B_2$ | 439.0 | 36,761,867,000 | $A_2$ $B_2$ | 5,595.0 |
| | 118,000,000 | $B_3$ | | 2,300,000,000 | $B_3$ | |
| | 60,000,000 | $D_2$ | | 5,136,000,000 | $D_1$ $D_2$ | |
| | | | | 1,800,000,000 | C | |
| Yukon | ..... | .. | .... | 250,000,000 | $A_2$ $B_3$ | 2,840.0 |
| | | | | 4,690,000,000 | $D_1$ $D_2$ | |
| North-West Territories | ..... | .. | .... | 4,800,000,000 | $D_2$ | 300.0 |
| Arctic Islands | ..... | .. | .... | 6,000,000,000 | $B_2$ $B_3$ C | 6,000.0 |
| Totals | 413,816,965,000‡ | .. | 26,219.31 | 797,920,284,000 | .. | 84,662.5 |

*Group II. Including Seams of 2 Feet and Over, at Depths Between 4,000 and 6,000 Feet*

| | | | |
|---|---|---|---|
| Nova Scotia (marine areas, 3 to 5 mile limit) | 2,639,000,000 | $B_2$ | 73 |
| Alberta | 12,700,000,000 | $B_2$ | 203 |
| British Columbia | 2,160,000,000 | $B_2$ | 11 |
| Totals | 17,499,000,000 | .. | 287 |
| Grand Totals | 413,816,965,000 | 26,219.31 | 815,419,284,000 | | 84,949.5 |

*Includes areas in which there are rocks found to be coal-bearing in other localities.

†In the above classification letters have been substituted for names. In a general way the classification conforms to the nomenclature used in America, as follows: $A_1$ = Anthracite; $A_2$ = Semi-Anthracite; $B_1$ = Anthracite and high-carbon bituminous; $B_2$ = Bituminous; $B_3$ = Low-carbon bituminous; C = Cannel; $D_1$ = Lignite or Sub-bituminous; $D_2$ = Lignite.

‡In this total, 20,000,000 has been deducted for the amount of coal of all classes already extracted in Alberta.

reserve shown is a computation based on the known coal areas and seams already tested, including the areas being mined. The coal that can be recovered is probably from 50 to 60 per cent of the indicated reserve (Table I).

To give even a fairly adequate idea of the coal resources of Canada it will be necessary to deal with the more important coal areas individually. These it is proposed to treat as they occur from west to east. The limits, however, of such an article as this preclude the possibility of describing the various coalfields in more than a somewhat sketchy and very general fashion, and readers who desire more detailed knowledge should consult the various official publications on the subject.[1]

## THE COAL RESOURCES OF BRITISH COLUMBIA

The province of British Columbia on the Pacific coast is well supplied with

[1] The publications of the Geological Survey of Canada, of the mines departments of the various provincial governments and of the Canadian Institute of Mining and Metallurgy, to all of which the author acknowledges his indebtedness in the preparation of this article, will be found very useful.

coal measures ranging in quality from lignite to anthracite. The greater part of the deposits are bituminous, although altered to anthracite in several localities. Coal has been produced and used in the province from the days of early settlement. It is recorded, for instance, that in 1836 the first steam-boat on the Pacific coast, the *Beaver*, used British Columbia coal under her boilers. The mountainous topography of the province has militated against favorable transportation and marketing conditions, as well as being responsible for a considerable area, especially in the north, remaining unexplored and unprospected. The estimated coal reserves of the province are placed by the most competent authorities at approximately 71,000 million tons, of which over four-fifths is classed as bituminous. Details of these reserves are shown in Table II.

TABLE II

COAL RESOURCES OF BRITISH COLUMBIA

*Group I. Seams of 1 Foot or Over, to a Depth of 4,000 Feet*

| | *Metric Tons* |
|---|---|
| Semi-anthracite | 1,349,950,000 |
| Anthracitic coal and high-carbon bituminous | 34,700,000,000 |
| Bituminous | 58,043,231,000 |
| Low-carbon bituminous | 2,418,000,000 |
| Cannel | 1,800,000,000 |
| Lignitic or sub-bituminous | 4,136,000,000 |
| Lignite | 1,060,000,000 |
| *Group II. Seams of 2 Feet or Over, at Depths Between 4,000 and 6,000 Feet* | |
| Bituminous (southern B. C., 11 sq. mi.) | 2,160,000,000 |
| Total | 71,001,881,000 |

Although coal measures are widely distributed in British Columbia, the important coal areas are more or less isolated. Commercial production has been confined almost entirely to three fields in the southern and better settled portion of the province. These are the Vancouver Island, the Interior or Nicola-Similkameen and the Crowsnest Pass fields. Less important deposits, of which, however, a great deal has yet to be learned, are in the Liard River, Peace River and Omineca districts and on the Queen Charlotte islands. At the head-

FIGURE 5.—The Crowsnest coal-field contains the largest deposits of high grade coal on the Pacific slope from Alaska to Mexico. The extensive establishment of the Michel Colliery of the Crowsnest Pass Coal Company, Ltd., at Michel, British Columbia.

waters of the Skeena, Nass and Stikine rivers in northern British Columbia there is an important area of anthracite and semi-anthracite known as the Groundhog Mountain district. It is as yet undeveloped, but the area outlined by prospectors comprises nearly 170 square miles.

The estimated reserves of the three important fields of the province are as follows:

| | *Tons* |
|---|---|
| Vancouver Island— | |
| Nanaimo district | 286,934,000 |
| Comox district | 547,005,000 |
| Suquash district | 55,000,000 |
| Nicola-Similkameen— | |
| Princeton district | 435,200,000 |
| Coalmont district | 110,636,000 |
| Chu-Chua district | 54,000,000 |
| Crowsnest Pass— | |
| Crowsnest district | 22,000,000,000 |
| Upper Elk district | 14,000,000,000 |
| Flathead district | 600,000,000 |
| Crown Mountain district | 200,000,000 |

## THE VANCOUVER ISLAND FIELD

Extensive faulting and irregular thickness of the seams, some of which vary from a few inches to over 30 feet in a lateral distance of less than 100 feet, are the main difficulties to be overcome in mining on Vancouver Island. The Nanaimo district's productive area is estimated at approximately 65 square miles. The area of the Suquash district has not yet been estimated with any degree of definiteness. The Nanaimo measures furnish a bituminous coal of fair grade,

whilst the Comox produce a coking bituminous coal, the highest in fixed carbon content of all the Vancouver Island coals.

### THE NICOLA-SIMILKAMEEN FIELDS

The Nicola-Similkameen coal-fields in the southern interior of British Columbia are widely scattered and broken, and the output varies from bituminous to lignite. The Chu-Chua deposits of low-grade bituminous with an estimated area of 5 square miles are located on the North Thompson River some 55 miles north of the city of Kamloops. The coal areas of the Liard River, of which not much is known, are lignitic in character. Fairly extensive deposits ranging from anthracite and semi-anthracite to lignite occur on the Queen Charlotte islands.

FIGURE 6.—Another view of the Michel Colliery that shows the mountainous character of the country in which the coal deposits are being worked. The topographic factor has a part in the transportation cost.

### THE CROWSNEST FIELD

The Crowsnest field, situated on the western slope of the Rocky Mountains, in the southern portion of British Columbia, constitutes the largest deposit of first-class coal on the Pacific slope between Alaska and Mexico. It covers an area of 378 square miles and reserves are estimated at 36,800 million tons. Unlike the Vancouver Island and Nicola-Similkameen fields, the Crowsnest is free from extensive faulting, albeit in some places rocky intrusions have broken it into different sections. The coal seams are of great thickness and are regular, but the overburden is heavy and mining operations have had to contend with large quantities of methane gas. In several places the coal-bearing rocks are as much as 4,700 feet thick.

Geologically, the coals of this field belong to the Kootenay formation, which persists also on the Alberta side of the provincial boundary. According to Dowling this formation produces the most valuable coal in Canada. In general, the quality of the coal in the

FIGURE 7.—A Vancouver Island mine, Mine No. 4, of the Canadian Collieries (Dunsmuir) Ltd., at Cumberland, British Columbia.

Crowsnest field is a high-grade bituminous, but semi-anthracitic varieties also occur. The majority of the seams furnish a very good coking coal as well as providing an excellent steam fuel.

### MARKETS

One of the chief difficulties of the coal trade of British Columbia has been to find markets. The Vancouver Island coals are used for the bunkering of ships, and for domestic heating and industrial uses on the mainland, especially in the city of Vancouver. Some is exported to the United States, as is also a portion of the output of the Nicola-Similkameen district. The coal from this last-named district competes with the Vancouver Island coals in Vancouver and the coast markets generally, but a considerable portion of it is used for railway purposes. On account of their adaptability to many uses, the Crowsnest coals have a wide market extending from their point of competition to the west with the Nicola-Similkameen coals to as far north as Calgary and as far east as Winnipeg. About three-fifths of the output is exported to the United States. These coals are used for railway fuel, for conversion into coke, for smelting, for domestic heating and for manufacturing purposes. The competition of fuel oil of late years, both on the railways, and for domestic and industrial purposes in Vancouver, has made serious inroads on the markets for British Columbia coals.

## THE COAL RESOURCES OF ALBERTA

The province of Alberta is particularly rich in coal deposits the quality of which ranges from semi-anthracite[1] to lignite. For a distance of over 700 miles from the international boundary northward, the Rocky Mountains and their foothills are studded with deposits of coal. The province contains 14 per cent of the coal resources of the world and approximately 87 per cent of the coal resources of

[1] This is often popularly called anthracite but many geologists claim that, strictly speaking, it should be classed as semi-anthracite.

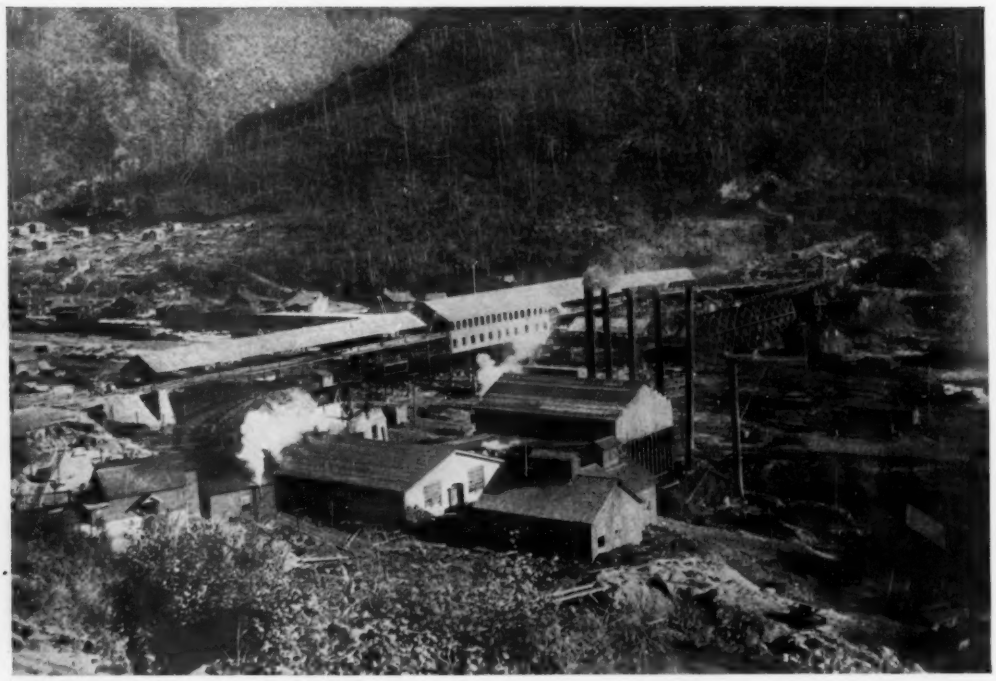

FIGURE 8.—The Coal Creek Colliery of the Crowsnest Pass Coal Company, Ltd., near Fernie, British Columbia.

Canada. Reserves, both actual and probable, are estimated at considerably over 1,000,000 million tons.

FIGURE 9.—An open coal mine at Tofield, Alberta, where mining is conducted on the level by the steel shovel method, at a low cost of production.

Coal is found in three distinct horizons or layers, the Edmonton formation, the Belly River formation and the Kootenay formation. The highest-grade and the hardest coals are found in the mountains, a lower grade in the foothills, whilst the extreme eastern portion of the coal-fields on the plains produces lignite.

Coal-fields in the Kootenay formation in Alberta are found on the eastern slope of the Rocky Mountains and in the foothills from near the international boundary northward to beyond the Athabaska River. North of that latitude most of the coal-bearing areas occur in the foothills. The principal districts where coal from this formation is mined, from south to north, are Crowsnest Pass, Banff-Canmore, Brazeau, Mountain Park and Jasper Park. The coal of the Kootenay formation is, in the main, bituminous, but in the Cascade basin it has been altered to semi-anthracite and semi-bituminous, the greatest alterations taking place in the Banff district. This basin, it is estimated, contains 400 million tons of semi-anthracite and 1,200 million tons of semi-bituminous.

### THE CROWSNEST PASS DISTRICT

The Crowsnest Pass mining district in this province is a continuation of the

same field in British Columbia. It extends from the interprovincial boundary to Burmis. The most important mining centres are at Blairmore, Coleman, Bellevue and Hillcrest.

### THE BRAZEAU DISTRICT

Proceeding northward along the Rockies, the next important field is in the Brazeau district, where a bituminous coal of good coking quality is mined. This coal basin is about seven miles wide and extends for a distance of 46 miles in a north and south direction between the North Saskatchewan and the main Brazeau rivers. The principal mines are at Nordegg.

### THE MOUNTAIN PARK DISTRICT

Farther north is the Mountain Park district, producing a high-grade steam coal, with areas being worked at Cadomin, Luscar and Mountain Park. The Jasper Park district is on the main line of the Canadian National Railway connecting Edmonton and Prince Albert and the principal workings are at Brulé lake. In the Peace River valley, deposits exist which are considered to be of about the same age as the Belly River beds. In the eastern part, only thin seams have been located but, to the west, seams two feet thick have been found.

### BELLY RIVER COALS

The Belly River coals, which lie next above those of the Kootenay formation, cover an area of about 16,000 square miles in eastern and southern Alberta. In quality they grade from low-grade bituminous to bituminous. They are widely distributed, the more important deposits mined being located at Lethbridge, Taber, Saunders Creek and Coalspur. South of Coalspur there is so little overburden that mining is carried on by steam shovel.

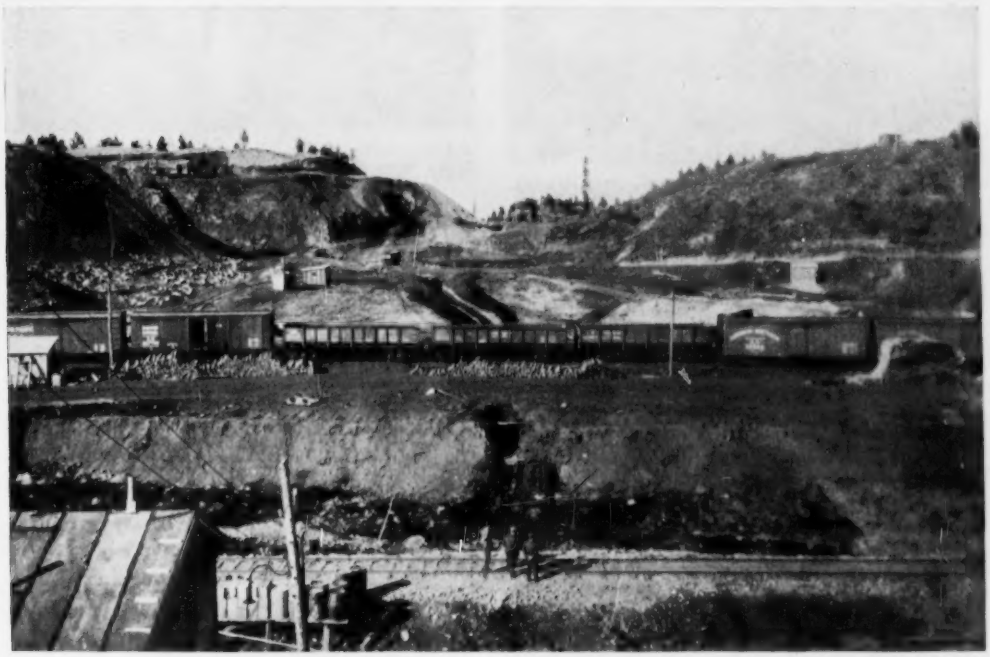

FIGURE 10.—Open mine conditions of more favorable character could scarcely be conceived than this pit of the Coal Valley Mine Company at Coalspur, Alberta.

### EDMONTON COALS

Coals of the Edmonton formation, which lies above the Belly River formation, also have widespread distribution,

the available deposits being estimated to cover an area of 52,405 square miles. The principal fields being worked in this formation are Drumheller, Edmonton and Pembina-Wabamun. The character of the coal changes from lignite in the extreme northeastern areas to a good coking coal in the foothills area. The Drumheller field produces a high-grade bituminous coal that will stand handling well. From a production standpoint, this field is the most important domestic coal-field in Alberta.

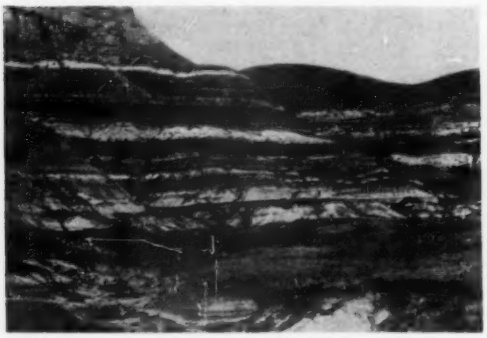

FIGURE 11.—A section of the formations carrying coal at Drumheller, Alberta. These formations extend over a great area and contain the largest part of Canada's vast reserves.

FIGURE 12.—The coal deposits of Alberta are readily adaptable to open mine development. The comparative ease with which mine operations are conducted in many of the Alberta coal fields is well illustrated.

## MARKETS

At the present time, the largest market for Alberta coal is found in the Prairie Provinces. Only a relatively small proportion of the output is exported to the adjoining northwestern states. The Alberta fields supply the domestic and industrial needs of Alberta, Saskatchewan, and Manitoba, as well as fuel for railway locomotives throughout these provinces. In Manitoba and especially in Winnipeg, keen competition has been met from United States anthracite and bituminous. During the war, however, Alberta coals practically drove the United States product out of the Winnipeg market, but this advantage, on account of the prolonged labour troubles in the Alberta mines during the summer of 1924, has been challenged. In this area, the United States coal has the advantage of an old-established and highly-organized industry, as well as of favorable transportation rates; for ore boats which would otherwise return empty from Lake Erie ports carry coal on their trip back to the head of the lakes, where it is stored till the autumn grain movement provides a large supply of cars at Fort William and Port Arthur to be loaded with coal on their trip back to the prairies for more grain.

FIGURE 13.—The Conmore Collieries in Conmore, Alberta, a relatively recent development.

FIGURE 14.—The tipple of the Cardiff Collieries, Ltd., at Cardiff, near Edmonton, Alberta, an excellent example of the most modern methods in handling coal at the mines.

The imperative need of the coal-mining industry in Alberta is wider markets. At the present time there are in the province nearly 400 mines in operation. These are capable of producing from three to four times as much coal as they can sell. Prospective markets are the northwestern United States, the coal bunkering trade for ships at Pacific ports, and the highly industrialized province of Ontario. The lowering of mining and transportation costs are the prime essentials if wider markets are to be gained and held. Unfortunately, coal mining in Alberta has been frequently beset with long-continued labour troubles. Due to a policy of unrestricted leasing of coal lands, mines much in excess of those needed to fill the demand have been opened, with the consequence that those in operation can work only a portion of the year. It has been found that the miners demand a yearly income of approximately $1,700 regardless of how many days in the year they work. The result of this, as well as of the high overhead charges caused by part-time operation, has been a relatively high cost of production. This has militated seriously against the extension of markets.

FIGURE 15.—The Galt Collieries, at Lethbridge, Alberta, another modern mine establishment.

## THE LIGNITES OF SASKATCHEWAN, MANITOBA, AND ONTARIO

Lignite is found in Saskatchewan and Manitoba. In the last-mentioned province, small deposits are found in the vicinity of Turtle Mountain, while the whole southern portion of Saskatchewan from Manitoba to the Alberta boundary is underlain by this class of fuel. Reserves of lignite in Manitoba are estimated at 160 million tons and in Saskatchewan at 59,812 million tons. The principal deposits occur in the Souris valley in southeastern Saskatchewan and it is from this area that about 90 per cent of the present production is derived. The chief producing centres are Bienfait, Estevan and Roche Percée.

Lignite is a cheap fuel and, although of low-grade, has been found of value to settlers in sparsely settled districts at some distance from railways. It occurs near the surface and consequently the ease of mining has increased its usefulness in this respect. In the Prairie Provinces it is used largely for domestic heating purposes, but its present market is mainly for the production of power. It is successfully used as a mechanical stoking fuel for steam purposes and its comparative cheapness makes it of value as a source of power in gas plants. As a commercial fuel its value has not yet been fully realized on account of the ease with which better-grade steam coals are obtainable from Alberta.

Carrying a high percentage of moisture (about 33 per cent on the average) it slacks readily on exposure to the air. This prevents storage during the summer months and the mining of it is, therefore, of a highly seasonal character. Experiments conducted by the Dominion, Manitoba and Saskatchewan governments jointly over a period of five years at a cost in excess of a million dollars have not yet proved successful in perfecting a commercially feasible method of briquetting Saskatchewan lignites.

Ontario is generally referred to as the coal-less province, but, strictly speaking, this is not true. Lignite deposits covering perhaps 10 square miles and having a maximum available tonnage of possibly 25 million tons, exist in the Moose River basin near James Bay on the slope from the height of land. These, although covered by a light overburden, are not, on account of their low grade and their

isolated location, of present economic value.

## COAL RESOURCES OF THE MARITIME PROVINCES

### NEW BRUNSWICK'S RESOURCES

New Brunswick has but meagre coal resources. Two thin seams exist, the upper averaging about 22 inches in thickness, whilst the lower seldom exceeds 10 inches. The principal mining districts are Grand Lake, Beersville, and Dunsinane. The total reserves are estimated at approximately 151 million tons. The coal is bituminous and contains in places a high percentage of sulphur and ash. Some shipments have been made during the last few years to central Canada. The output of the province is not capable of large expansion since the deposits are limited and the seams are thin.

### THE COAL RESERVES OF NOVA SCOTIA

The estimated coal reserves of Nova Scotia are 9,719 million tons, or less than 1 per cent of the reserves for all Canada. This proportion, however, is not a true index of their importance. Because of geographical conditions they are of much greater value than such a comparison would indicate. Their distance from other coal-fields, their proximity to large deposits of iron ore, their nearness to important centres of population, and their location on the seaboard, as well as the uniform and good quality of the coal produced, combine to give them an economic significance that their extent alone would not justify.

The province has the only coal deposits on the whole Atlantic seaboard of North America and South America. The nearest coal-fields in the United States are some 800 miles away and, barring the small Grand Lake field in New Brunswick, there are no coal deposits in Canada nearer than Alberta, a distance of over 2,000 miles. The Nova Scotia fields are, moreover, located at the entrance to the St. Lawrence waterway and cheap water transportation facilities are thus afforded into the centre of Canada, resulting in a large coal trade being built up to serve the territory as far east as Montreal. The proposed deepening of the St. Lawrence canal system will probably enable Nova Scotia coal to compete seriously with United States bituminous in western Ontario markets. Finally, the nearness of the immense Wabana iron ore deposit in Newfoundland just across Cabot strait from the Cape Breton coal-field has provided that unique combination of coal and iron which has so often spelled industrial supremacy for nations. Canada's largest industrial concern, the British Empire Steel Corporation has been based upon this foundation. Strategically placed both as regards raw materials and in respect to water transportation to world markets, it possesses a heritage, the full significance of which has not yet begun to be realized.

There are five coal areas in Nova Scotia with important collieries operating in all. These areas are the Cumberland field including the Joggins and Springhill areas, the Pictou fields, the Inverness (mainly submarine), the Richmond and the Cape Breton or Sydney fields containing both land and submarine mining areas. The accompanying table gives the estimated amount of coal in these fields with an indication of its quality.

The coal is of the bituminous class. The principal difference between the coals of Sydney and Pictou is a slightly higher ash content in the latter, although the former has a higher percentage of sulphur. The Springhill coal is low in sulphur and is cleaner than the Sydney coals. They are all steam or coking coals and make a strong metallurgical coke.

The Nova Scotia mines supply the domestic fuel and industrial needs of the province, although even here, despite the handicap of distance, some United States coal finds sale. Normally, over 50 per cent of the output is consumed locally in the iron and steel industry. One of the main outlets is the St. Law-

TABLE III

ESTIMATED COAL RESOURCES OF NOVA SCOTIA

*Group I. Seams of 1 Foot or Over, to a Depth of 4,000 Feet*

| District | Actual Reserve (Based on actual thickness and extent) Tons (Metric) | Class of Coal | Area (Sq. Miles) | Approximate Probable Reserves Tons (Metric) | Class of Coal | Area (Sq. Miles) |
|---|---|---|---|---|---|---|
| Cumberland county | 682,000,000 | $B_2$ | 60 | 250,000,000 | $B_2$ | 5 |
| Colchester | ..... | .. | .. | 1,000,000 | $B_2$ | 1 |
| Pictou | 345,550,000 | $B_2$ | 11 | 450,000,000 | $B_2$ | 8 |
| | 45,000,000 | C | | | | |
| Antigonish | ..... | .. | .. | 20,000,000 | C | 1 |
| Richmond | ..... | .. | .. | 12,360,000 | $B_2$ | 4 |
| Inverness (land area) | 61,800,000 | $B_2$ | 5.75 | 22,000,000 | $B_2$ | 10 |
| (submarine area) | 86,000,000 | $B_2$ | 4 | 73,000,000 | $B_2$ | 7 |
| Cape Breton county, land area | 1,022,496,000 | $B_2$ | 92.66 | ..... | .. | .. |
| | 5,415,000 | C | | | | |
| Marine, 3-mile limit | ..... | .. | .. | 4,063,457,000 | $B_2$ | 168.5 |
| Totals | 2,248,151,000 | .. | 74.31 | 4,891,817,000 | .. | 273.5 |
| Less amount mined | 60,000,000 | .. | .. | ..... | .. | .. |
| | 2,188,151,000 | | | | | |

*Group II. Seams of 2 Feet and Over, at Depths Between 4,000 and 6,000 Feet*

| | | | | | | |
|---|---|---|---|---|---|---|
| Cape Breton county— Marine, 3 to 5 miles | | | 73 | 2,639,000,000 | $B_2$ | 73 |
| Grand total | 2,188,151,000 | .. | .. | 7,530,817,000 | .. | 286.5 |

rence market which, as previously mentioned, is served by cheap water transportation. The closing of the St. Lawrence river by ice in the winter makes it necessary to ship large reserves during the summer to meet the winter demand.

In 1914 over 2,600,000 tons of Nova Scotia coal were marketed in the province of Quebec, but, on account of the disorganization of the trade caused by the war, this market was almost entirely lost. It is being steadily recovered, however, and at the present time absorbs from 25 to 30 per cent of the output,

FIGURE 16.—The modern well-equipped plant of the Cumberland Coal Company, at Spring Hill, Nova Scotia. One of the important concerns in the production of coal in the Maritime Provinces.

FIGURE 17.—Docks and blast furnaces of the British Empire Steel Corporation, at Sydney, Nova Scotia, where the excellent ores from Belle Isle are reduced and refined. The steel industry of Sydney is one of its most significant industrial developments.

shipments being made mostly from the Cape Breton collieries.

### MARKETS

The securing of a place in the markets of central Canada by Nova Scotia coal is entirely a matter of price in competition with the well-organized bituminous coal industry of the United States. Frequent labour disputes have increased the cost of production in Nova Scotia as in Alberta, whilst the high cost of submarine mining as reserves are depleted is another factor which conduces toward rising costs. One authority gives it as his opinion that it is not probable that the coal deposits of Nova Scotia can be usefully or advisedly developed to produce more than 10,000,000 tons annually.[1] Taking this as a criterion and considering the fact that in 1913, the year of maximum production, the output was 7,263,000 tons, it can be seen that there is not a large margin for expansion. Some allowance must, of course, be made in the contrary direction for the discovery of new deposits, the installation of modern machinery, and the adoption of more efficient methods of mining the seams which are known to extend long distances under the sea.

FIGURE 18.—The great blast furnaces of the British Empire Steel Corporation of Sydney, Nova Scotia, in immediate proximity to the coal mines of that locality. Here the ores of Belle Isle and contiguous deposits meet the fuel necessary to their manufacture. Steel is an important product of Nova Scotia in the world's trade.

## THE ADJUSTMENT OF CANADIAN SUPPLY TO DOMESTIC DEMAND

It is still a debatable question whether Canada can supply the coal-less provinces of Ontario and Quebec with fuel from her own mines. Indeed it is not altogether a foregone conclusion that such a consummation is economically desirable. The problem is not so difficult as regards fuel for industrial purposes as it is in the case of fuel for domestic heating. Nevertheless the bituminous consumption of central Canada for the 5-year period ending 1923 averaged 11,000,000 tons a year out of an annual average of 14,000,000 tons of this coal imported into the whole country. An ameliorating factor is that this area is abundantly supplied with waterpowers, which are being rapidly developed to replace fuel for industrial purposes. For domestic heating, however, central Canada, especially Ontario, is markedly dependent on the United States. Its anthracite imports in the period above-mentioned averaged 4,000,000 tons a year as compared with an average of 4,500,000 tons annually for all Canada. Moreover, the coal-consuming public of Ontario have become so prejudiced in favour of anthracite that it has been a matter of some difficulty to secure a fair trial for substitutes. But constantly recurring interruptions in the anthracite supply, due to labour troubles and transportation tie-ups, together with the increasing price and the deteriorating quality of this fuel, are having their effect, and a serious effort is now being made to encourage the use of substitutes and to develop a measure, at least, of national self-sufficiency in fuel.

This effort was officially sanctioned when the Dominion Government in 1922 formed the Dominion Fuel Board. This is a permanent body of departmental administrative and technical experts whose function is to study the fuel resources of the country with a view of making Canada as independent as possible of foreign sources of supply. Among its numerous activities have been investigations of central heating, by-product coke as a domestic fuel, efficiency in fuel utilization, the possibilities of the

[1] F. W. Gray, in *Bulletin of Canadian Institute of Mining and Metallurgy*, October, 1922.

use of low-volatile coals for domestic heating, and insulation of houses, as well as a survey of the extent to which anthracite substitutes are being used. The coal resources of the country are being studied with a special view of alleviating the condition of the "acute fuel area," as it is aptly termed, of Ontario and Quebec. The Board has given encouragement, although such aid has been only of a moral and sentimental character, to the importation of Welsh anthracite and, largely as a result, considerable quantities of this high-grade fuel have been imported and extensive grading and screening plants have been erected in Montreal. It has also been charged with the administration of the subvention (not exceeding 50¢ a ton) recently granted by the Dominion Government to coal shipped from the Maritime Provinces to points in Ontario and Quebec where competition exists with United States coal.

To supply the "acute fuel area" presents, of course, the major problem to be solved. How can the populous area of Ontario and Quebec be rendered reasonably independent of the dwindling supply of high-cost United States anthracite? In 1923 a strong effort sponsored by the Dominion Fuel Board was made to import trial shipments of Alberta coal into Ontario. Sir Henry Thornton, President of the Canadian National Railways, made the experiment of reducing the freight rate from $12.70 to $9.00 a ton for train-load lots shipped in the summer months before the heavy grain movement began. Under this arrangement some 50,000 tons of Alberta domestic coal were brought into Ontario. With its free-burning qualities, its low-ash content, and its comparative freedom from the smoke so characteristic of most bituminous coals, it proved very satisfactory fuel for Ontario householders. The low freight rate, however, was conditional on the cost at the mine being reduced, and, unfortunately, labour troubles in 1924 prevented such reduction. Indeed, they made impossible a supply at any price. In its distance from the point of consumption Alberta coal has a tremendous handicap to overcome.

Conceding the point that the Nova Scotia fields could supply a large demand from central Canada, it is doubtful whether they could compete successfully in Ontario with United States coal until the St. Lawrence waterway has been improved to permit the passage of larger boats. As Nova Scotia coals are of the smoky variety, they would not be a factor in the solution of the domestic heating problem unless converted into coke. Many of them are somewhat high in sulphur for this purpose, but it is thought that by blending them with higher-grade coking coal from the United States they might be utilized. Several experiments of this kind have recently been made under the auspices of the Dominion Fuel Board.

Possibly the most promising new fuel for the acute fuel area is domestic coke made from bituminous coal obtained either from the United States or Nova Scotia, or from both. Although the limits of the United States anthracite fields are in sight, this is not true of the bituminous areas. The reserves of these are described as practically inexhaustible. The mines now have an annual capacity of 300,000,000 tons in excess of the needs of the United States. This bituminous coal can be used in Ontario and Quebec to produce gas for the large cities and supply coke for domestic heating, as well as producing various other by-products such as tar and ammonia. By-product coke is a comparatively new fuel for Canadians, although it has been manufactured for some years (mainly for metallurgical purposes) in Nova Scotia. In 1924 a plant of the most modern type was erected in Hamilton, Ontario, and is securing a ready market for its output.

It is a somewhat singular circumstance that the burden of all discussion on Canada's fuel problem has been the desirability of bringing the country's

large natural resources in coal from the west and from the east to the thickly populated central area. Little or no attention has apparently been given to the reverse process, namely, the bringing of population to the coal areas. And yet, why not? Economic history teaches us that large coal resources, especially when minerals are near by, have always acted as a magnet for population. The coal areas of Nova Scotia, Alberta and British Columbia with valuable metallic mineral areas adjacent, are favored with a healthful climate; whilst conditions exceedingly suitable to agricultural pursuits prevail in the surrounding territory. When such a movement of population will begin is, of course, idle to prophesy, but to deny that it will take place some day would be to ignore the experiences of the past. When Canada's coal areas are industrialized, she will have begun to realize on the tremendous national asset she possesses in her one-sixth share of the coal resources of the world.

# A LAND POLICY FOR THE PUBLIC DOMAIN

*George Stewart, Agronomist*

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A DEFINITE land policy for the unreserved and unappropriated public domain must be formulated and adopted very soon if the best utilization of this national asset is to be achieved. Chaos and loss impend if the problems of developing wisely our public lands are not soon solved; the successful extension of our food-resources and the continued maintenance of our high standard of living depend, in a measure, upon the satisfactory administration and use of our public land.

FIGURE 1.—Cattle grazing on the Montezuma National Forest, Colorado. The mountain watersheds and tree-covered tracts constitute the summer range; the stockmen own or lease a headquarters ranch with buildings for shelter in bad weather. (Photo by U. S. Forest Service.)

About 185 million acres of land are grazed under the old system of land laws. Under these laws grazing is unregulated and the competition for a given range is keen; rival owners rush their stock to the ranges the first day of spring, compete all season for the best pastures, and struggle for the last grass of autumn. Not only does the pasturage value of the plant cover decrease, following removal of edible species by this close grazing, but also the best soil moves off in the first freshet.

In contrast, the 110 million acres of grazing land in the National Forests are

efficiently utilized under a permit system. The Forest Service has faithfully protected the timber and watersheds assigned to its care, and incidentally has controlled grazing and stabilized the stock industry by building up the carrying capacity of big ranges, by preserving the integrity of the soil mantle, and by promoting good will among the graziers, of whom none would now be willing to revert to the open range system.

FIGURE 2.—Eroded range on Sargent Mountain, Fishlake National Forest, Utah, consequent upon overgrazing. No grazier attempts to improve or to protect an open range, where his competitor may profit by the better pasturage. (Photo by U. S. Forest Service.)

The seasonal use of the different land areas complicates the situation. The mountain watersheds and tree-covered tracts constitute the summer range; the stockmen own or lease a headquarters ranch with buildings for shelter in bad weather and with hayfields to supply a small feed reserve for emergencies (Fig. 1). Autumn, winter, and spring pasturage for their animals must come from farms or the open and uncontrolled public lands in the valleys. These lands, more than one and one half times as extensive as the summer range, have no system of supervision, merely because they are treeless or not watersheds (Fig. 2). No stockman can afford to risk his whole enterprise on a range where another herdsman may preëmpt the pasturage; nor will any grazier attempt to improve or to protect an open range, when the better pasturage merely encourages a competitor to reap the resultant benefit and profit.

## THE PUBLIC DOMAIN

The national government at one time or another has owned an aggregate of 1455 million acres of public land.[1] About twenty-three per cent of this total is still owned by the nation. Approximately 150 million acres, or ten per cent, have been designated as National Forests, of which about 110 million acres are suitable for grazing. In addition, 185 million

[1] This is exclusive of Texas, none of whose land has been owned nationally, and the state land reserved by the thirteen original colonies.

acres are entirely without control. This unrestricted public domain constitutes the "storm center" in the West today.

The remaining public domain, consisting principally of land not suited to agricultural development, lies almost entirely west of the Mississippi (Fig. 3). Much of it is mountainous or "desert" land. Some cannot be utilized because it is handicapped by swamps, stumps of cut-over timber, insufficient water (either for irrigation or for culinary use), or inadequate transportation. Portions lie at altitudes so high that untimely frosts constitute a limiting factor for crop production. The public land left to the nation is distributed by states as shown by Table I.

TABLE I

Vacant Public Land in Eleven Western States

| *State* | *1923* |
|---|---|
| Arizona | 14,951,860 |
| Colorado | 7,753,129 |
| California | 18,091,187 |
| Idaho | 10,040,912 |
| Montana | 5,908,156 |
| Nevada | 52,690,645 |
| New Mexico | 16,491,564 |
| Oregon | 13,677,583 |
| Utah | 25,242,338 |
| Washington | 1,184,558 |
| Wyoming | 18,717,183 |

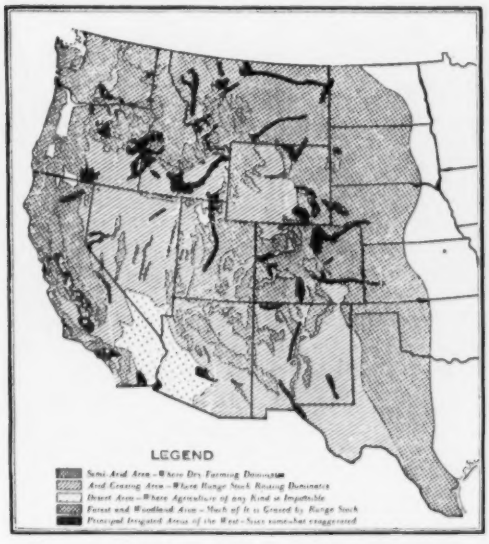


FIGURE 3.—Western United States, where most of our Public Domain now is. Much of it is mountainous or desert land; portions lie at altitudes so high that untimely frost constitute a limiting factor for crops and unfavorable topography prevent cultivation. (After Wooton, U. S. Dept. of Agriculture.)

Small tracts throughout the country will eventually be added to our crop area, but no extensive regions of good farmlands are left (Fig. 4). This is the chief reason for the rapid advance in land prices within recent years. Recent investigations on reclamation projects indicate that the high cost of bringing water to the land will retard the development of such tracts as can be reclaimed only by this means.

As the pioneers moved out of the forested regions east of the Mississippi they came into open prairie land. In a few years the "little prairie" was occupied, and then the wave of settlement advanced into the "big prairie," a region of vastly different possibilities but of somewhat similar appearance. Though long grass gave way to short grass, it was still grass and seemed to be the same. The difference was thought to be due to firing on the part of the Indians. Settlers frequently had encountered drouth and waited till it passed. Now, though they did not realize the fact, they were in the region where drouth was the usual, and ample rainfall the unusual condition. Native vegetation was resistant to drouth, and in the favorable climate, cured standing. In the Southwest many species did not die down to the ground each winter. All this lent strength to the idea that the region could support cattle without number.

After 1833–1834, when military posts were established in the region west of the Missouri River, records of the arid region began to be kept, chiefly in the form of letters. In 1847 the Mormon migration began, and in 1849 the rush to California swept over. Thousands of horses, mules, and oxen were wintered on the Plains and in the valleys of the Rocky Mountains without hay or grain. The luxuriant grasses, cured naturally into hay, furnished excellent winter forage.

In the Rocky Mountains and thence westward to California, the grasses

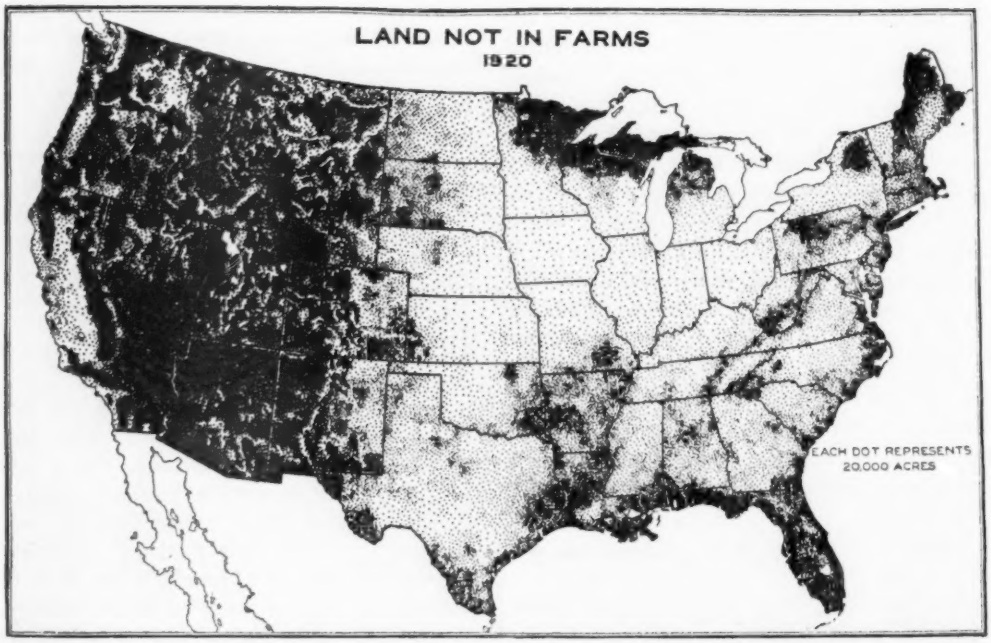


FIGURE 4.—Land not in farms, 1920. Over ninety per cent of the land added to the crop area, between 1910 and 1920, was previously in pasture, the rest in forest. No extensive regions of good farm lands are now left unoccupied. (After Henderson, U. S. Dept. of Agriculture.)

formed sod only in the wetter sloughs and well-watered valley bottoms. On the benchlands and foothills the bunch-grasses were interspersed with weeds and small brush. In the more favorable spots the rye-grasses (*Elymus* sp.) grew as tall as a man and sometimes taller. As feed abounded everywhere, and grass grew even among the sages or with only a few sages interspersed in grassy places, there was no thought of injury or of need for protection. The same condition prevailed in the eastern foothills and on the higher Plains, where the short sod-grasses dominated except in the drier regions of bunch-grass. Even these bunch-grasses sufficed to winter stock successfully.

Immense quantities of feed were wasted every year and gave rise to exaggerated notions of the carrying capacity of the region. The following extracts indicate the forage condition of the country in early days and also the impression it made on enthusiastic men.

J. W. Iliff, a stockman of Cheyenne, Wyoming, wrote at some time before 1870:

"I have been engaged in the stock business in Colorado and Wyoming for eight years, and consider the summer-cured grasses superior to hay. My cattle have not only kept in good order on this grass through all the eight winters, but many of them, thin in the fall, have become fine beef by spring. During this time I have owned 20,000 head of cattle. The percentage of loss is much less than in the States where cattle are stabled and fed on corn and hay." [2]

Alexander Majors, a professional freighter, (before 1870) wrote:

"I have been grazing cattle on the plains and in the valleys and mountains for twenty years, and during that time never had less than 500 head of work cattle, and for two winters, those of 1857 and 1858, I wintered 15,000 head of heavy work oxen on the plains each winter. My experience extends from El Paso, on the Rio Grande, to one hundred miles north of Fort Benton, in Montana. Our stock is worked during the summer, and

[2] "The Texas Cattle Trail," *United States Department of Agriculture Report*, 1870, p. 303.

comes to the winter herding-ground thin. There it grazes without shelter, hay and grain being unknown. By spring the cattle are in good working order, and many of them are fat enough for beef."[3]

This immense undeveloped resource was thought to be limitless and indestructible. Only time and sad experience convinced the enthusiasts that this was not so. Vision and prudence would have guarded against the wanton waste and destruction that followed; but it is far easier to discern mistakes in retrospect than in the prospect.

FIGURE 5.—Sheep grazing in Arizona. Great herds of sheep grazed through the country, first on one range and then on another, so closely cropped the pasturage that the grass-cover weakened and died, and brush, weeds, and undesirable species came in to replace it. (Photo by U. S. Forest Service.)

## EXPLOITATION AND DETERIORATION

The "Ranchers' Frontier" accompanied the tide of American settlement from the Piedmont in Virginia to the plains beyond the Mississippi. Every state from New York and North Carolina, to Iowa had epochs of grazing, while crop production was yet in the pioneer stage. Immense stretches of open grass on the Plains, however, gave cattle ranching its greatest impetus. Mexican land grants in Texas initiated the ranching practice there prior to Texan independence. Following annexation enormous ranches grew up in a few years, but cattle were so low-priced that just preceding the Civil War many ranches were abandoned, and the cattle "ran wild." Then, as war caused prices to rise from four dollars or five dollars a head to fifteen or eighteen dollars, the boom set in; as New Orleans and other southern towns could not utilize the cattle, they were driven north to loading stations on the rail-

[3] "The Texas Cattle Trail," *op. cit.*, p. 303.

road,—for several years Abilene, Kansas, and Ogallala, Nebraska, were favorite loading points. Great drives over the "Texas Cattle Trail" included anywhere from 35,000 (1867) to 600,000 (1871) head each year.[4]

### OVERGRAZING

Since cattle on the drive required water, they were herded over the same general routes where water was obtainable. Naturally, after several herds had trod the trail and bedded at the same water holes, feed began to grow scarce, especially around the watering places. This was one of the first noticeable signs of overgrazing. The business was so profitable, however, that great companies were promoted and cattle were sold to new concerns rather than to meat markets. English and Scotch capital flowed freely into the Plains region, and ranching spread northward and westward into the less favored areas. For a time, overproduction and low prices caused the loss of many investments. Overgrazing began to manifest itself in the denuded ground near water holes and in the scarcity of winter feed. Heavy losses accompanied every severe winter. In 1886 heavy losses followed a winter of heavy snow, extreme cold and lack of winter feed in Colorado and Wyoming.[5] Drouths of unusual intensity occurred in Arizona and New Mexico in 1893–1894, causing the death of innumerable cattle by starvation.

In the nineties tramp stockmen began to pass through the country, grazing first on one range and then on another. Sheep, moved in such a fashion, could almost denude a range in one passage (Fig. 5). This forced resident stockmen to graze much more heavily than they would otherwise have done, in order to keep out the tramp herds. When spring came, the cattle, then thin and undernourished, were driven at once to the greenest early feed and then to the next, before other stockmen moved their animals to the same range. In the Rocky Mountain region this practice of early grazing came to be especially objectionable, as the animals followed the receding snow far up the mountains, cropping the first green growth. Others, coming behind, ate the second and third growths as soon as they started. In a few seasons the plants weakened and died, the poorer forage plants, brush, and weeds occupied the ground and especially on permanent bedding places, the nearly useless Douglas knot-weed usurped the land. Under heavy and early grazing, only those plants persisted that were not eaten before seed production.

In 1898 Bentley estimated that in central Texas, a region of 100 miles by 200 miles in extent, could have at one time supported 400 cattle to the square mile.[6] About half of this, or 10,000 sections, was range land. He considers 320 cattle to the section as really conservative for 1880, but estimated that only sixty-four could have fed on a section by 1898. This decrease of eighty per cent is probably exaggerated, but it reveals what happened. Barnes and Jardine, however, estimate that from 1905 to 1914 in the eleven far western states a diminution of about fifty per cent had resulted in some regions, and imply that this does not include a considerable previous decrease in carrying capacity.[7]

This situation arose largely because of "free grass." Though the land was public domain and no one had a right to fence it, some fencing was done. The ranchers made a code for themselves as to territory and privileges. "Range rights," as these codes were called, meant nothing to the tramp stockman who merely drove through the country. As bands of sheep

[4] Mumford, H. W., and Hall, L. D., "Economic Factors in Cattle Feeding—A Review of Beef Production in the United States." *Illinois Experiment Station Circular*, No. 169, p. 6 (1913).

[5] Barnes, Will C., *Western Grazing Grounds and Forest Ranges* (1913), p. 26.

[6] Bentley, H. F., "Cattle Ranges of the Southwest—A History of the Exhaustion of the Pasturage and Suggestions for Its Restoration," *United States Department of Agriculture, Farmers' Bulletin*, 72 (1898), pp. 19–20.

[7] Barnes, W. C., and Jardine, J. T., "Livestock Production in Eleven Far Western Range States," *U. S. Department of Agriculture, Secretary's Report* 110 (1916), p. 12.

were in charge of herders, they could go almost where they chose. In some localities resident cattlemen surrounded the few water holes and shot sheep as they came in. The temptation to "take a shot" at a particularly aggressive sheep herder or cowboy soon became too strong to be resisted. There were several feuds in which a number of men were killed. Tonto Basin in Arizona was probably the scene of the worst, but there were many other cases almost as bad. Firearms were not the only weapons used; night stampedes into sheep herds, poison, fire, and driving herds into swollen streams, were all tried in one place or another.

FIGURE 6.—Area denuded through grazing, Wallowa National Forest, Oregon. The fine, rich top-soil is removed from the entire surface; gullies soon develop in the trails, and down the slopes; and not only the grass but the roots are destroyed. (Photo by U. S. Forest Service.)

## EROSION

These prevalent bad conditions in the range lands rapidly grew worse. The plant cover was disrupted and soil began to erode rapidly (Fig. 6). Fine rich top soil was removed from the whole surface; gullies developed in trails and down bare slopes. Soon these grew into washes and then into ravines (Fig. 7). Stream flow became unusually high in spring and low in late summer.

In addition, valley lands were ruined. For example, small towns had been built in the narrow valleys of the upper Virgin in southern Utah; the land was farmed and produced abundantly. Consequent upon over-grazing of the range on the watersheds, floods brought down coarse gravel and buried the good soil under it; in other places most of the good surface soil went down stream to cover another area or to form a quicksand in the lower reaches of the river, where animals

"bogged" as they tried to get out to the water during the period of small flow.

The Great Basin Experiment Station of the United States Forest Service in Ephraim Canyon, Utah, has made a comparative study of the two adjacent erosion areas. Where vegetation has been permitted to grow and die down each year naturally, there are several inches of valuable black leaf-mold and about a foot of friable soil above the heavy impervious hard-pan. The grass roots hold the mold and soil firmly in place. The porous surface readily absorbs the rain and allows it to percolate into the soil where it can come into contact with the plant roots. On the other area where the vegetation is closely grazed each year, the sod is broken, the soil is compacted, rills have developed, and the surface mold and friable soil have been washed down into the canyon.

If grazing is discontinued or properly controlled, an eroding range gradually recovers. Manti Canyon, Utah, may be taken as an example. Floods occurred in 1888, 1889, 1893, 1901, 1906, 1908, 1909, and 1910. No serious flood is reported previous to 1889. Sheep grazing began in the section five or six years before and gradually reduced the plant-cover until the flood of 1888 broke through and developed gullies. Thereafter, deluges were frequent until all stock was excluded for the five-year period from 1904 to 1909. During this period, the plants recovered sufficiently to absorb most of the water that caused the flood on nearby areas in August, 1909. Manti Canyon was barely flooded, whereas unprotected Ephraim and Six-Mile Canyons in the path of the same storm and receiving the same amount of rainfall, were seriously eroded. Great quantities of soil and rock were thrown out into the valleys, completely ruining some farms. Mt. Pleasant had the same experience in June, 1918. Canyons where grazing was controlled were

FIGURE 7.—Deep wash and destructive erosion in the Dizie National Forest, Utah, due largely to trails and overgrazing. The trails develop into washes, the washes into ravines. (Photo by U. S. Forest Service.)

not flooded, but the continuously grazed canyon of Mt. Pleasant poured a river of water, mud, and stone directly into the town, and across apple orchards and fields of alfalfa, grain, and blue-grass. A gully from three to twenty feet deep was ripped open through the town and across some of the best farming land, of which much will never again be cultivated, because of the mantle of mud and boulders spread over it.

Grazing control and timber management cannot prevent all floods; a combination of the two might eliminate most of them and materially decrease the destruction caused by those they cannot prevent.

## ADVERSE INFLUENCES

A number of adverse influences, some of them directly attributable to the lack of a definite land policy, and the consequent lack of control and supervision, have more or less seriously affected the grazing industry and prevented the best utilization of the range lands. The private monopoly of water, and the presence of wild horses, rodents, and poisonous plants, have locally spoiled the range and adversely affected grazing.

### WATER MONOPOLY

Throughout much of the arid region, suitable watering places for animals, always scarce, have become more so as percolation diminished with increased run-off (Fig. 8). If a man controls the only watering place in a region, he holds the area so far as grazing is concerned.

In western Boxelder, Tooele, Juab, Millard, Beaver, and Iron Counties, Utah, and in much of Nevada large areas, often several miles in extent, have only one water hole. For example, Fish Springs is many miles from any other surface water. In Wah-wah Valley of western Beaver County another spring absolutely controls the grazing for six to nine miles in every direction.

What is true of Utah holds for the arid region in general. In the southwest corner of Wyoming on the Uintah-Rich

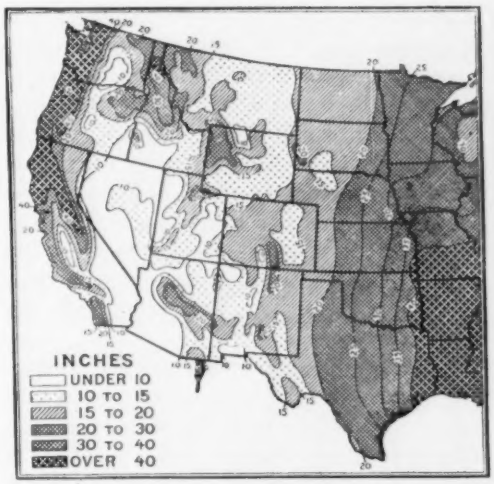


FIGURE 8.—Average annual precipitation; rain, snow, sleet, and hail. Much of the range land is in regions of summer aridity where suitable watering places for animals have always been scarce, and with increased runoff, are very rare indeed. If a man control the only watering-place in a region he holds the key to the grazing of all the nearby range. (Map from 1921 Yearbook, U. S. Dept. of Agriculture.)

Grazing Reserve, one concern bought up alternate railroad sections and homesteaded ten or twelve "forties" of public land with all the water that was not on the railroad lands. This arrangement yielded almost complete grazing control of a tract fifteen by thirty miles, half of which is public land domain.

Another example is afforded by part of the state of Nevada. Ranching began on the usual scale; many small ranchmen took up the drainage area of a stream. Each owned a tract of land with some water for stock and irrigation. All ran stock on the public domain. Everything went well until a tramp sheepman drove his band into the section. One ranchman found that the feed he had counted on had been eaten off. He crowded his neighbor, who, in turn, trespassed on the range rights of the next. Soon, one ranchman bought up the claim of a neighbor and a year or two later that of another. As time went on he acquired land at prices beyond any reasonable hope of return, yet he gained control of all the watering places in his part of the valley. Others did the same,

and shortly, a few monopolized the whole drainage area. By this process, tramp stockmen were kept off the open range, because there was no place to water their stock. Thus the necessity of protection developed large ranches with monopoly of the watering places. The ranchmen actually owned five to ten per cent of the land, but virtually possessed 90 to 95 per cent of the public range, which was useless without the key land with its enclosed water.

Such conditions promoted the ownership of most of the best land by a few corporations instead of by many farmers. One typical ranchman owns a tract eight miles by three miles, and in addition controls some seventy square miles of public domain. All the work is done by transient laborers, without homes, families, church, school, or ideals of citizenship.[8] This area under irrigation could support 1500 people with good homes, fine schools, and healthy social life. The land suitable for farming remains ranch meadow. As hay-producing land it is worth about fifty dollars an acre, whereas it would be worth about one hundred fifty dollars an acre as small general farms. Yet, it will remain ranch property because it is key land to a water monopoly giving the owner control of several times as much public domain grazing lands.

## WILD HORSES

Horses introduced into the Southwest by the Spaniards escaped from the Old Spanish Missions, multiplied rapidly, and virtually became wild. They spread widely over the West and became so numerous in parts of Idaho, in Southwestern Utah, in Southwestern Nevada, adjacent parts of California, and in Tooele, Juab, and Millard Counties, Utah, as to be a menace to stockmen. Thousands of horses were shot or poisoned. Later, in Utah, a group of semi-ruffians found a market somewhere in the middle West—rumor has it in the meat-packing plants of Kansas City and other towns,—where the best were sold at auction, and the others made into corned "beef." Though the people of Tooele, Juab, and Millard Counties only surmised the fate of these horses, they saw thousands rounded up and shipped out. Mustangs, while almost extinct in southern California and Nevada, are a great nuisance in eastern and southern Utah and parts of Arizona. Wild asses also are numerous in some regions.

Suitable control would automatically rid the domain of this trouble.

## RODENTS

Prairie dogs and ground squirrels increased with incredible rapidity after cattle became numerous in the arid region, because stockmen waged a relentless war against wolves, coyotes, badgers, snakes, owls, and hawks, the natural enemies of these pests. The prairie-dogs and squirrels destroy feed that might be eaten by cattle or sheep. Since their favorite food is forage upon which the stock was dependent, the stockmen have become alarmed.

The extent to which these pests can affect grazing is indicated by the following: it has been estimated that one area, one hundred by two hundred fifty miles in Texas, supports 400 million prairie dogs, and that they ate enough to maintain one and one half million head of cattle.[9]

The ground squirrel is much smaller than the prairie dog, but the damage he does to pasturage is considerable. According to estimates for the whole region, from ten to fifty per cent of the feed is destroyed by these pests.

During the last few years, these nuisances have been abated considerably by poison campaigns in the more heavily infested areas; but many yet remain and will continue to do damage until they are exterminated.

[8] Adams, Romanzo, "Public Range Lands—A New Policy Needed," *American Journal of Sociology*, Vol. 22 (1916), pp. 324–351.

[9] Merriam, C. Hart, "The Prairie Dog in the Great Plains," *Yearbook of the Department of Agriculture* (Washington, 1901), pp. 257–270. Ref. page 258.

### POISONOUS PLANTS

As the ranges became depleted and feed became really scarce, cattle died when they grazed in certain localities. Several dead animals were often found close together in a place. They were badly bloated and showed symptoms of having been poisoned. Cattlemen accused sheep herders who, though claiming innocence, were unable to account for the sudden death of the cattle. When sheep also began to die, the sheepmen concluded that the cattlemen had retaliated, and bitter warfare began. The recurrence of these deaths in certain gullies seemed to confirm the suspicion of poisoning. Careful investigation proved that poisoning had actually taken place, not from malicious intent on the part of either party to the controversy, but from poisonous plants that had survived the denudation of the overgrazed range.

As a range is depleted and the good forage plants become scarce, other species that are less relished by stock that can survive these unfavorable conditions invade the area. Constant heavy grazing prevents the seeding and reproduction of the more palatable plants. Partly because they are unpalatable and are therefore not eaten but allowed to seed, and partly because they can survive in poorer soils, these plants replace the more edible species. Among the coarser and less palatable species are a dozen or so that under certain conditions are poisonous to cattle or sheep or both. A great increase in the number of poisonous plants is generally an evidence of overgrazing.

On well-preserved ranges, poisonous plants do not become widespread or numerous, nor do animals eat those that do occur. As a group, the poisonous species are so unpalatable that they are eaten only when animals are extremely hungry and more choice vegetation is not available. It is now commonly recognized that mismanagement of the range is the chief cause of loss due to plant poisoning. Poisonous plants have come in because their competitors have been reduced and the soil rendered less productive by overgrazing and erosion; they will be replaced by desirable forage when proper grazing control permits the recovery of the range.

## ADMINISTRATION

From the Atlantic Coast to the Missouri River, crop-growing has completely replaced grazing as an industry based on public land. Corn and wheat, the favorite pioneer crops, have been followed by diversified crops and livestock.

Grazing in any part of this region was temporary. The people and the Government regarded it as a short-lived industry that would disappear with the advance of settlement, and they made no effort to regulate the use of public land for grazing. If any regulations had been attempted in the East the land would have passed rapidly into crops before the regulations could have become operative. The grazing industry there was regarded as transitory and soon to be replaced by crop-growing. When the western arid regions began to be settled, grazing there was naturally considered from the same viewpoint. With the initiation of dry-farming on the Plains everybody felt that the only difference between the grazing industry of the West and that of the East lay in the kind of farming that would succeed it. However, the general failure of even dry-farming (Fig. 9) in the arid region—except in favorable localities,—has left to the land a per-

FIGURE 9.—An abandoned dry-farm, grown up to Russian thistle. It is no longer fit for grazing even. Years of slow development are necessary to restore the grass cover upon such land.

manent grazing industry but no national policy for its development or control.

### NATIONAL FORESTS

By 1891 it had become clear that free and unrestricted rights to cut timber from the public domain, and to graze animals upon it, had brought about an undesirable state of affairs. Our timber supply was no longer considered inexhaustible, as once it had been; the good timber was either becoming scarce or reculinary water supply, found the water muddy a large part of the year, and often tainted with manure washed in from adjacent bedding grounds.

In 1891 President Harrison set aside Yellowstone Park Timberland Reserve as the first part of the public domain to be reserved from free and unrestricted use. At intervals from 1891 to about 1911, forest reserves were set aside, principally in the West, for most of the land in the East had already

FIGURE 10.—Horses and cattle grazing upon the Uintah National Forest, Utah. To facilitate control of the forest ranges, the officials require stockmen who wish to range cattle, horses, sheep, or goats, to make written application for permits for a certain number and kind of animals. (Photo by U. S. Forest Service.)

stricted to inaccessible places. Floods had become deplorably common in certain regions where timber had been removed from the watersheds; forage on the ranges was badly overgrazed, at least near the watering places; in the irrigated regions the canals and farm ditches were clogged with silt, sand, and gravel brought down by the swollen streams; and many towns, dependent on streams for their passed out of Government hands. By 1921 nearly all the timbered watersheds that had not become private and corporate properties were set aside in the reserves and designated as National Forests. In the eleven far-western states, the forests aggregate about 135 million acres, of which most are so mountainous and so high as to be untillable.

The National Forests are so adminis-

tered under a permit system as to give the officials in charge control of the kind and number of animals grazed on a given area; their distribution, whether grazed alone or along with other kinds of animals; the times at which they are turned on and taken off; and the issuance of permits (Fig. 10). Immediately after 1900 our National Forests increased most rapidly and the Forest Service evolved the main features of its present policy.

In order to facilitate control of the forests, the officials require stockmen who wish to range cattle, sheep, or goats to make written application for a certain number and kind of animals (Fig. 11). Resident farmers and stockmen are accorded first privileges, then the larger stockmen so far as the ranges can accommodate the animals without endangering the forest. Beyond this limit, grazing permits are denied and the numbers reduced. Nominal fees are charged to pay for control and supervision. These are much smaller than pasturage rentals and carry with them insurance against competition from extraneous sources.

### ATTITUDE OF STOCKMEN

At first stockmen resented this form of control, and considered it an infringement upon their personal rights to free grass.

FIGURE 11.—A good grazing range on the Uintah National Forest, Utah. Grazing permits are limited to a number that will safeguard the pasturage and promote the continued good quality of the range. (Photo by U. S. Forest Service.)

In 1903 the Public Lands Commission gathered information as to the condition of public grazing lands. Among other forms of investigation, a questionnaire was sent to stockmen in the West, with inquiries regarding the condition of their open ranges, their management, and the advisability of extending the permit system to the remaining open range. About

1400 replies were received with answers complete enough to permit tabulation.[10] Of these, 961 reported that the carrying capacity of their ranges had diminished, and 276 said they had increased in capacity. Of the 961 who reported decreased capacity, 752 said the chief contributing cause was overgrazing. Of the 1400 replies returned, 532 favored the development of a system of private pastures and 353 others community allotments. Most striking of all, however, were the answers to the question: "Do you favor Government control of the ranges, under reasonable regulations?" In all, 1091 answered "Yes," 183 "No," and 127 failed to answer. This indicates that 20 years ago stockmen had come to realize the benefit of Government regulation after having seen it tried for a few years.

The report of the Public Lands Commission, already cited, recommended a plan for land classification (Fig. 12) and administration by districts. The Forest Service was to be given general charge, but considerable powers were reserved to the local graziers of the area designated. In spite of official insistence, and local approval from the stockmen, nothing has as yet been done, though twenty years have elapsed.

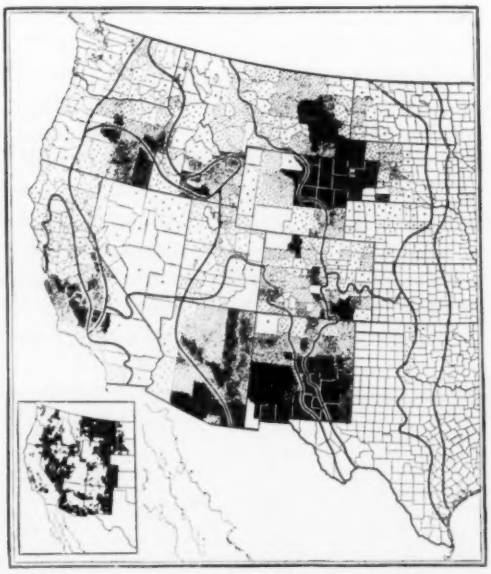

FIGURE 12.—Land classified as available for 640-acre grazing homesteads. The small map shows land designated as 320-acre enlarged homesteads. The large map indicates land suited only for grazing. Each dot represents 5000 acres. (After Henderson, U. S. Dept. of Agriculture.)

### LEASING AND FENCING IN TEXAS

In Texas, previous to 1883, overstocking and premature grazing had developed serious difficulties. Watering places were denuded for miles around; competition for feed and consequent feuds and range strife had created a state of guerilla warfare in many sections; rustling was common; heavy losses resulted from severe winters, drouth, poisonous plants, and general lack of inducement to improve the range land by developing water, by building vats for tick control, and by introducing better stock. Some ranching concerns found fences so advantageous in herding, in feed insurance, in reduction of rustling, and in increase of the calf crop, that immense tracts were fenced without authority. Though indiscriminate fencing without legal authority was a dangerous principle, it was deemed so helpful if properly legalized, that it brought about revision of the laws relative to fencing.

In 1883 the whole area of publicly owned land in Texas was organized under new state land laws, possible because the commonwealth retained ownership of the land according to its annexation agreement with the United States. These laws have been revised several times to make enforcement more feasible or more effective. In 1901 the laws covering both fencing and disposal of public lands were nearly enough perfected to become actually operative, and with only minor revisions they stand intact today (Fig. 13). Leases, large enough to be economically practicable, permitted purchase at one dollar an acre, and have so encouraged settlement as to terminate practically the public ownership of much land.

[10] Potter, A. F., "Questions Regarding the Public Grazing Lands of Western United States," *U. S. Dept. of Agriculture, Forestry Service Bulletin*, 62 (1905), p. 11.

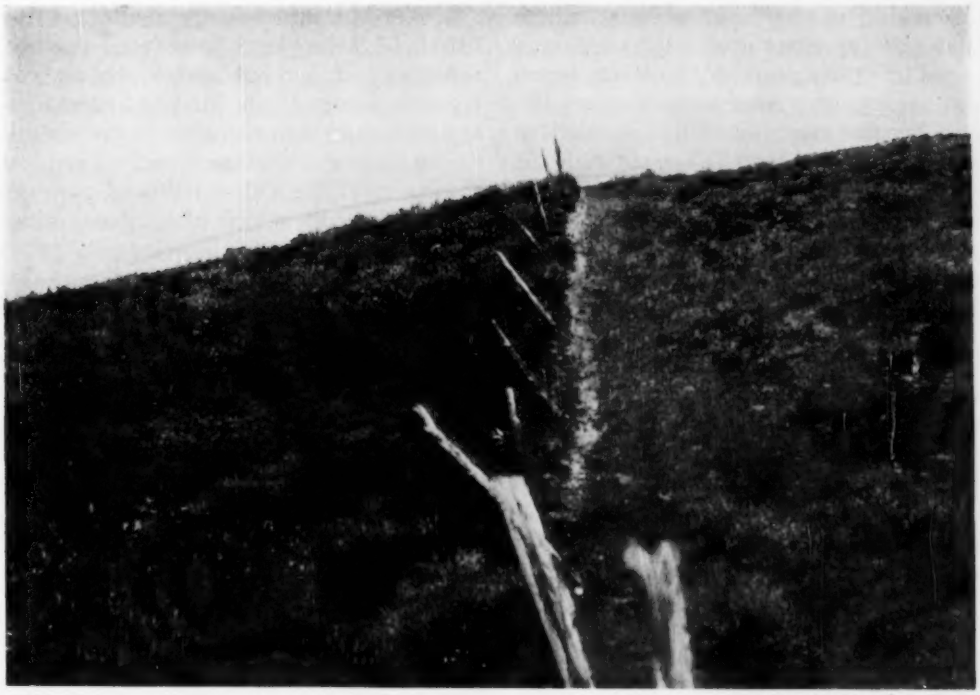

Figure 13.—A contrast in method and management: on the right overgrazed Public Domain; on the left privately owned range of the same original quality. The value of protection is clearly illustrated.

Free range grazing for thirty-five years converted most people to the idea that it was not profitable. After another thirty-five years under the leasing system, probably not any intelligent stockman would consider a return to open range. In 1904 the number of cattle on the ranges of Texas was almost double that of 1884. During the last twenty years the number has increased further and the quality of cattle has been improved notably.

### Leasing in Wyoming

Wyoming, when admitted as a state in 1890, was allowed about four million acres of land. All except about 530,000 acres of this was school and educational land. Wyoming lacks the advantage Texas had in controlling the entire public domain. The land laws set the selling price of state land at ten dollars an acre and provide that not more than 640 acres of school land may be leased by any one person; there is no such limit on the non-educational, state-owned land. Since ten dollars an acre is considered an exorbitant price for ordinary range land, none has been sold. The rental fees are two and a half cents an acre for land without streams or good watering places, five cents an acre for land with watering places, and twenty-five cents an acre for irrigable land. Leases may extend for five years and are subject to three preferential lease periods, constituting twenty years of reasonably secure tenure.

In practice about sixty per cent of the state-owned land has been leased for five-year periods at an average rental of between four and five cents an acre. The income has been about $100,000 a year. The forty per cent of land not leased is chiefly in isolated single sections that are so located as to be too small, or otherwise impractical as unit leaseholds.

### Leasing Railroad Lands

The Northern Pacific Railroad just previous to 1904 leased considerable land in the state of Washington. The land grant for the Northern Pacific consisted of alternate sections for fifty miles on

either side of the right of way, which land was for years used without charge as public grazing land by both sheepmen and cattlemen. After several years the land became overgrazed and seemed to have little sale value. Then the railroad company set about devising a method not only of obtaining income to cover taxes and other expenses, but chiefly of restoring the land to such a condition that it could be sold.

A number of large sheep owners who had been grazing the lands scorned the idea of recovery and objected to leasing when the company proposed that plan. Though cattlemen also grazed the lands, the big stockmen involved were sheep owners. The Washington fence law was so worded that sheep grazing on unowned range except that controlled by the Federal Government constituted a misdemeanor. Since the sheepmen objected to leasing, the railroad obtained an injunction against thirty of the largest owners in eastern Washington to prevent their grazing the railway lands. This led to a meeting between stockmen and railroad officials, at which a lease was arranged. In 1896 lands were leased primarily to the men who had used them previously. Cattlemen, seeing that without legal tenure rights to part of the land they would be without range, also leased.

In the central part of the state, twenty-nine of the stockmen resisted by forming an organization, of which the members agreed not to lease unless the railroad would give a written contract to keep all other animals off the leased land, and unless the fees were no more than taxes. They bound themselves to pay proportionate expenses for any litigation that might arise from resistance of the lease-system, and further agreed not to lease unless their own general committee approved the plan. The deadlock seemed fast and remained so for a time, but finally some individual owners weakened and applied for leases. By the end of 1898, 237 leases, including practically all of the land, had been taken.

Under the more secure tenure of the leasehold, the land recovered rather rapidly, and purchasing became active. By 1904 nearly all the land had been sold and the stockmen completely converted to the idea of control or lease. The fact that in 1900 the Yakima Wool Growers' Association, to which the twenty-nine organized objectors all belonged, petitioned their members of Congress to do everything in their power to bring about a Government leasing system for public grazing lands, indicated the radical change in attitude.

### TENURE OF GRAZING LANDS IN AUSTRALIA

A practical leasing system is illustrated in Australia. During the period of early settlement in Australia, large corporations developed and took possession of the land, principally by "squatters" privilege. Later, when home-making settlers began to come in they found all the best land occupied by the large companies. This retarded or prevented settlement. Accordingly, laws were passed compelling the owners of the grazing animals to pay rental fees. It was expected that this would break up the "bonanza" ranches, but officials found that the ranchmen merely paid the lease fees, and kept the land even more complacently than before.

In 1884 New South Wales by a revision of its land laws, changed the whole situation. All pastoral leases were called in by the Government and divided into two approximately equal parts, of which one was returned to the original lessee.

With half the land in its control, the Government organized a lease system to encourage small owners to settle in the region. Provisions for purchase or lease, or a combination of both, were made in such a way that leases extended for seven years with renewal preferences so arranged as to make the tenure virtually twenty-one or twenty-eight years.

Lessees are required to act in good faith and to use the land leased. Purchases are handled in much the same manner,

and settlement proceeds rather rapidly. The general government of the Commonwealth classifies the land, and the fee is fixed according to this classification, varying in amount from sixty cents a square mile for the poorest desert land to fourteen cents for an area of the better land large enough to carry one sheep. The rental is fixed every seven years, but the lessee may ask for an appraisal at any time. At the end of the seven-year period, the lease may be relinquished if the lessee so desires, but if he chooses he may continue for twenty-one or twenty-eight years.

In case of prolonged severe drouth, rental fees may be held in abeyance for six months or a year. (In one protracted drouth the suspension continued for nearly three years.)

Any improvements put on the land belong to the lessee who may either remove them or sell them by agreement to the new lessee if agreement is reached. In case no agreement is reached he retains tenant rights to them, which condition is covered by law. Certainty of tenure for a relatively long period, with assurance that improvements shall not be lost, has made the Australian leasehold system extremely satisfactory to individual stockmen who do not have sufficient capital for land purchase or who for some other reason do not wish to buy land.

## CONCLUSIONS

Since the present method of free grazing on the public domain has been accompanied by calamitous consequences, this question now presents itself: What concrete revision is to be sought? Many are prepared to answer off-hand in favor of a certain system that each has evolved in his own mind or that he has borrowed from somebody else. Consequently, it appears more advisable to outline definitely the suggestions that have been made by men who are thinking of the problem, and then to state the apparent advantages and disadvantages of each. Certainly, it is time that the men, who hold at their disposal the destiny of our public domain, should take the matter into serious consideration.

The following plans of handling public domain seem to deserve close study and a thoughtful consideration of relative merits:

1. A federal or state leasing system, similar in a general way to that of Texas, of Wyoming, and of Australia.
2. Federal permit system, similar in a general way to that now in operation on the National Forests.
3. Federal control that will classify lands and encourage settlement on all, except a small percentage not capable of becoming successful privately-owned ranches. This assumes a continuance of the permit system, on the present National Forests and an extension of the same, or of a similar system, to that part of the public domain which remains winter range.

The Leasing System (1) has two distinct advantages: (1) governmental control without heavy burdens of administration and development, and (2) a direct income of considerable revenue. Opposed to these are two disadvantages: (1) leaving the management of the land for forage in the hands of individuals, with the likelihood of temptation to overgraze, at least near the end of the lease; and (2) leasing has not brought about the really successful coöperation in the United States between the lessee and government that we are told prevails in Australia and several European countries with regard to land purchase and rural credit generally.

The possibility of turning all remaining public land over to the eleven respective range states for their control, utilization, and administration is sometimes agitated. Danger of conflicting state policies and the greater cost of administering the land in eleven systems instead of one are against this plan. Such action would increase the possibility of short-sighted policy in order to obtain temporary benefit. Every state would also have to bear the expense and danger of political manipula-

tion without the protection which a national organization could afford.

The principal provisions of a proposed Federal permit system (2), may be summarized briefly as follows as adapted from Potter's recommendation:[11]

1. Public lands of the arid states are to be occupied for grazing under Federal permits only.

2. The public land is to be classified into lands suited for settlement and those suited only for grazing. Irrigable lands not likely to be irrigated in the relatively near future are to be classified as grazing land.

3. Lands suited for settlement are to be grazed under annual permits, but grazing land is to be handled under five-year permits.

4. Long permits of ten or fifteen years may later be allowed on land which subsequent experience shows to be unquestionably fit only for grazing.

5. It is definitely recognized that 160-acre homestead claims, and also the later enlarged claims of 320 and 640 acres, are much too small in the area fitted only for grazing. Four to eight sections are suggested.

6. All grazing land is subject to reclassification at the end of permit periods, at which time land reclassified as suitable to settlement (either farms or family-sized livestock ranches) shall be open for private filing for a short time. If not entered within time specified, the land shall be leased once more.

7. The plan also recognizes the likelihood of certain areas not being suited to individual permits. A group, or community, permit arrangement is suggested.

A classification of the land of the public domain (3) seems desirable because of the great diversity of geographic conditions. A classification based on use would make it possible to handle each type of land under whichever system promises the fullest ultimate development. This would place some under Federal leasing, some under Federal permit system, and some in a class ready for absorption by private citizens but subject to restrictions that would prevent consolidation by corporate interests. The task is recognized as gigantic, but not as unsurmountable. Political and financial interests—not the physical problem, tremendous though it certainly is—are regarded as the most difficult.

There is no tenable reason why the present state of no control whatever should continue as an incubus on the grazing industry. No small part of the insecurity and hazardous nature of the livestock industry in the West at the present time is due to inaction on this vital question. The destruction of the grazing value of this public domain cannot be defended. An intelligent, disinterested commission with power to act could devise a workable plan in a short time. In fact specific legislation has been recommended.[12] Why should politics interfere in so vital a matter?

[11] Potter, A. F., *op. cit.*, pp. 65–67.

[12] Potter, A. F., *op. cit.*, pp. 65–67; Wallace, H. A., "The Year in Agriculture," *Yearbook of the United States Department of Agriculture*, (1923), Washington (1924), pp. 71–72.

# THE RELATION BETWEEN THE DISTRIBUTION OF POPULATION AND OF CULTIVATED LAND IN THE SCANDINAVIAN COUNTRIES, ESPECIALLY IN SWEDEN

BASED ON SOME RECENTLY PUBLISHED MAPS AND AGRICULTURAL LITERATURE

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INTEREST in geographic questions has undoubtedly increased rapidly since the world war. This renewed interest, and the many new political boundaries, have stimulated cartography in almost all countries of the world to a more rapid development during the last few years than in any preceding similar period. The great nations have each published one or more large atlases of the world. Following their lead several of the small countries have likewise printed atlases and have succeeded in selling them, not only in their own coun-

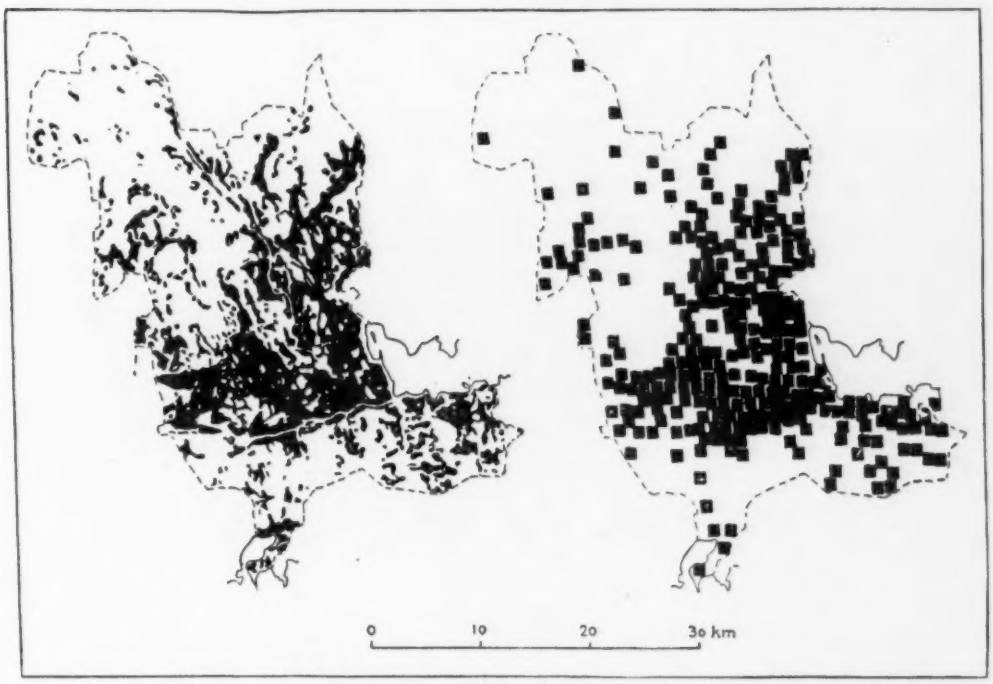


FIGURE 1.—Sketches, printed in black only, showing on the left the exact distribution of cultivated land in the township (härad) of Akerbo in the county (landskap) of Västmanland in Central Sweden, and on the right a section of C. J. Anricks' map of cultivated land, where the distribution is indicated by squares. The original map is printed in black with the squares in orange, the water in blue, and in paler blue the coastal area submerged in late-Quaternary time.

Certainly a map prepared as shown on the left is preferable to the map on the right, but even if it were possible to draw such a map for Sweden by mainly using the land survey maps which show each farm (almost on the scale of 1:4000) it would be a very expensive work. The total surface of all the squares is equal to the total land area, because the areas covered by the squares are equal to the area they represent. When the cultivated area is very large or nearly 100 per cent of the total one can not in this way use dots because it is impossible to put dots together without any intervening area. If the two sketches be held some distance from the eye the general effect, it will be noted, is similar.

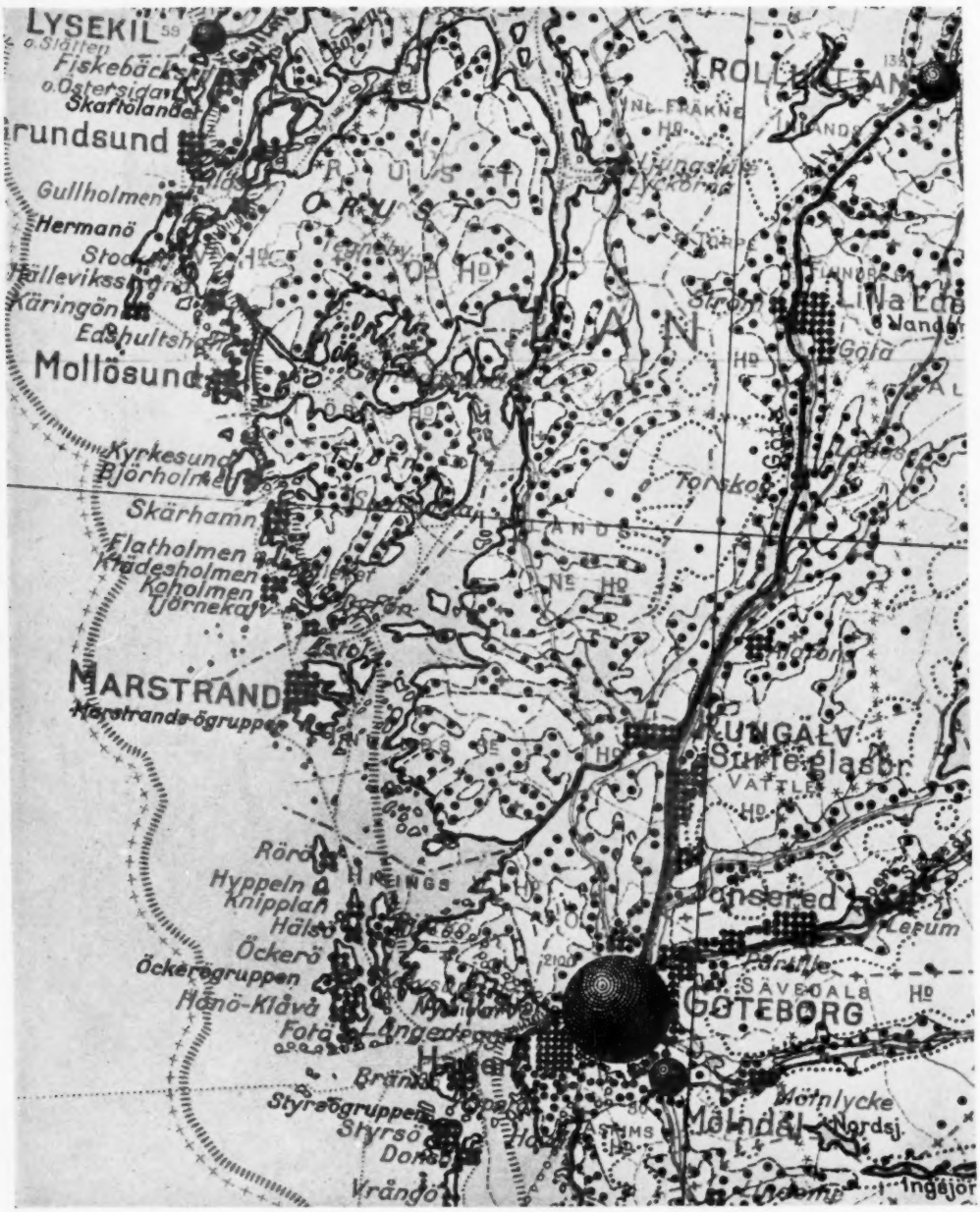


FIGURE 2.—A Section of Sten De Geer's population map printed in black on the original scale of 1: 500,000. Sketch shows the distribution of the population in the district around Göteborg, the greatest export seaport of Sweden. Each of the small dots represents 100 inhabitants. These dots are located where the people live. The population of the cities of Göteborg (210,000 inhabitants), Mölndal (8,000 inh.) and Trollhättan (13,000 inh.) och Lysekil (6,000 inh.) could not be represented by dots because the areas of these cities are too small to contain the requisite number of such small dots. Sten De Geer was therefore compelled to use spheres, which are proportionate in size to the small dots.

The original map shows that the surburban populated districts around Göteborg radiates like the arms of a star fish from the city, following the River Göta älv with the Canal of Trollhättan and the seven larger roads and six railroads in the different valleys. The area distribution of population in the environs of a large city is interesting.

FIGURE 3.—A Section of A. Söderlund's population map. Sketch printed in black showing the district of Lofoten Islands in Northwestern Norway, one of the greatest cod-fishing districts in the world.

The solid circles represent the permanent population of those Islands, while the hollow circles indicate the temporary inhabitants who live on the islands only during the fishing season. One can see that during the fishing season the population of these small islands is increased about seven times and is concentrated in habitations like cities and villages. The original map is printed in black for population, and in red for communication facilities, in green for boundaries, in brown for names, and in blue for water.

try but also in foreign lands. These atlases are noteworthy, not only because of the subject matter which they present, but also because of the very excellent cartographic methods which they illustrate. In the countries of Scandinavia, map-making is keeping pace with other scientific progress; among these atlases, four published in the Scandinavian countries, deserve particular mention: *The Swedish Red Cross Atlas*,[1] *Atlas of Norway*,[2] *The Swedish Tourist Association's Atlas of Sweden*,[3] and *Atlas of Finland*, third edition now in preparation.[4]

## NEW MAPS

Of more interest than the atlases even, are the several maps of Sweden and of the other Scandinavian countries prepared during these later years by a special method. These interesting maps, studied separately or together, are helpful in presenting clearly the relation between the utilization of the land and the population.

This brief article will discuss only four maps: (1) *Map of the Distribution of the Population in Sweden*, January 1, 1917, by Sten De Geer;[5] (2) *The Distribution of the Population in Norway*, by Alfred Söderlund;[6] (3) *Map of the Distribution of Cultivated Land in Sweden*, 1913–1920, by Carl Julius Anrick;[7] and (4) *Map of Scandinavia*, by Sten De Geer, Alfred Söderlund, and Bror Thordeman.[8]

[1] Svenska Röda Kors Atlasen. Stockholm.

[2] Ekonomisk Atlas over Norge, Kristiania.

[3] Svenska Turistföreningens Atlas över Sverige. Stockholm.

[4] Atlas över Finland. Helsingfors.

[5] Sten De Geer—"Karta över befolkningens fördelning i Sverige den 1. January, 1917." Scale 1: 500,000; 12 sheets and 296 pages of text with 18 figs. Price, 75 Swedish crowns. Published by Wahlström and Widstrand, Stockholm, 1919.

[6] Alfred Söderlund—"Befolkningens fördelning i Norge. Bidrag til folketetthetskart over Norge." Scale 1: 1,000,000; 2 sheets and 155 pages of text with 4 figs. Price, 2/40 Norwegian crowns. Published by Norges Geografiske Opmåling, Kristiania, 1923.

[7] Carl Julius Anrick—"Karta över Sveriges åkerareal enligt absolut metod sammanställd efter Statistiska Centralbyråns officiella publikationer 1913–1920." Scale 1: 1,000,000; 2 sheets and 77 pages of text with 15 figs. Price, 8 Swedish crowns. Published by Sveriges Geologiska Undersökning, Ser. Ba. No. 10, Stockholm, 1920.

### STATISTICAL DATA

The method adopted in these maps is "the absolute method," devised and used in Sweden by Sten de Geer as early as 1906. As is well known, the idea of the method is to show by a dot, a circular plane, a square, or some other figure a definite number of people, area of forest, quantity of production, or other quantitative unit, and repeat these units on the map in places corresponding to their correct location. In this way a clearer picture and a more exact knowledge of the distribution is possible than from the older maps, in which the data were presented by the "relative or percentage method." By this relative method, the population, for example, were removed from their homes, so to speak, and uniformly distributed over a larger or smaller administrative division. By the absolute dot method, the details and the right geographical distribution can be better visualized. For instance, the cultivated land and population in a dominantly forest area can be represented by a chain of dots and a thin wedge of color stretching upwards along the river valleys, forming a strong contrast with the forest land and sparse population lying between the valleys. The railways with their concentrations of people at the stations are shown sometimes like a string of beads in the thinly populated woodlands, while the plains of Denmark and South Sweden appear as almost uniformly cultivated and densely populated areas.

### POPULATED AREA AND CULTIVATED LAND

Statistics indicate that nearly 50 per cent of the population in Sweden is engaged in farming during the farming season; but some of this farm population

[8] Sten De Geer, Alfred Söderlund och Bror Thordeman—"Norden." Scale 1: 500,000; 2 sheets and a shorter text. Price, 20 Swedish crowns. Published by Generalstabens Litografiska Anstalt, Stockholm, 1923.

is occupied at other seasons in fishing, lumbering, and forestry. The corresponding percentages of Norway and Finland are 45 per cent and 65 per cent respectively, and for the United States, according to O. E. Baker, 31 per cent.

Because the main part of the Scandinavian non-agricultural populations dwells in cities or towns, one is led to the *a priori* expectation of finding that maps bring out forcibly the congregations of population due to trade, manufacturing, and other localized industries. Despite the superiority of the absolute dot-method over any other devised, particularly in the portrayal of small units, the method, however, does not, in its present form, adequately express to the untrained eye the exact relation between congested districts and those of more moderately concentrated population, when the transition from one to the other is abrupt, and larger units of design (squares and circles) are employed for larger units of population. The agricultural population is relatively overemphasized by the method, and this fact

FIGURE 4.—Map of Sweden's cultivated land, according to C. J. Anrick. Scale much reduced.

FIGURE 5.—Map of Sweden's population, according to Sten De Geer. Scale much reduced.

is well illustrated by a comparison of Sten De Geer's population map with Anrick's map of the distribution of cultivated land.

If these maps had been printed in but one color they should have coincided closely in their portrayal of the population densities, but this they unfortunately do not do so well in their present form. A comparison of the two maps on a very reduced scale (Fig. 4 and Fig. 5) confirms the discrepancy, particularly in the relative density of the agricultural and urban populations. To facilitate the comparison only the socalled "densely populated districts" have been presented on these small-scale reproductions.[9]

### DISCREPANCIES IN DISTRIBUTION

The principal discrepancies between the two maps are caused by the many non-agricultural residents in rural districts. At the beginning of 1919 the total population of Sweden was 5,813,850, of which 4,144,986 were living in rural districts, but of which only 2,673,613 were actually farmers and their families, or engaged in some pursuit connected with farming. The 1,482,373 living in rural communities but engaged in non-agricultural pursuits represents the reason for one discrepancy between the maps. To this number of non-agricultural inhabitants of country districts should be added the miners and iron-workers of Norrland and the seven thousand Lapps, who live beyond the northern limit of cereal production. Thus it is evident that over 25 per cent of the population of Sweden, though engaged in non-agricultural pursuits, lives in rural communities.

The divergence between the pictures of population presented by these two maps would have been even greater were it not for the fact that wherever people live and engage in any industry that the natural resources permit or give rise to, they bring under cultivation some part of the land, no matter how unfavorable the conditions for its utilization, as soon as the concentration of population tends to bring it above submarginal productive value.

Some illustrations of discrepancies in distribution, only slightly indicated on the map, are as follows:

1. The textile manufacturing district in southwestern Vestergötland;
2. The glass manufacturing district; chiefly in southeastern Småland,
3. The coal mining district in northeastern Skåne;
4. The fishing district, chiefly in Bohuslän;
5. The sawmill district, chiefly littoral belt of Norrland where the rivers open upon the sea;
6. The iron-works district, chiefly in Bergslagen, in central Sweden.

The importance of the two last enumerated districts, of major consequence in the economic life of Sweden, is inadequately indicated by the maps.

## SIMILARITY OF CONDITIONS

Similar natural conditions in Sweden and the other Scandinavian countries render the statements thus far made of Sweden equally applicable to them. Sweden constitutes a transitional connection between these lands, its southern province, Skåne, resembling Denmark, and its northern and middle sections resembling Norway and Finland, but in Norway the fisheries and electro-chemical industries give rise to more populous districts than they do in Sweden.

### TOPOGRAPHY

Roughly speaking, half the population of Scandinavia is agricultural. The maps reveal how intimately related is the distribution of this farm population to the distribution and character of the tillable land. The "densely populated

[9] In Sten de Geer's own opinion an area shaded or colored to show a densely populated district is merely a generalized way of showing the population distribution as indicated by dots.

FIGURE 6.—A heavy crop of winter wheat on the fertile plain of Skåne (Scandia), the southernmost province of Sweden.

districts"[10] occupy the areas of "improved land"[11] as it is known in America, and these areas of improved land coincide very nicely with the areas of favorable topography. The dense farm populations, like the best tillable lands, are found on the larger and more continuous plains; below the upper sea-level during late Quaternary time when clay could be deposited, the more sparsely populated farm sections of less easily tilled land are the hilly wooded morainelands; while the mountain tracts are practically without tillable land or farm population.

Throughout Scandinavia climatic factors play only a secondary part in the distribution of population and cultivated lands, except in the northernmost reaches, and the rainy coastal belt of Norway. In the choice of cultivated plants and in the yield of harvested crops planted, the climatic and other factors are more evident.

[10] Sten De Geer's "Tätbygd."

[11] Anrick's "Åkerbygd," especially "Helåkerbygd" and "Åkertätbygd."

## GEOLOGIC FACTORS

The geologic factors may not be ignored, particularly in their indirect effect upon the soils, which add their influence to topography in the favorable agricultural conditions of the plains areas. The Cretaceous underlies parts of Skåne, the southernmost province of Sweden, and the islands of Denmark. Limestones, sandstones, and shales, principally of the Cambro-Silurian, underlie mainly the other cultivated plains of Scandinavia. Archean granites, gneisses, schists, and other eruptive rocks of various kinds constitute most of the Scandinavian terrane, and on them, both the topography and the soil are unfavorable to farming but suitable for forest growth, particularly of conifers, which furnish nearly all the export lumber of Scandinavia today. Over great tracts, the Pleistocene glaciers wore away the entire mantle of soil and decomposed rock, so that any detrital material now existent has been formed in postglacial time, and in some places has not developed into a soil; in other places very

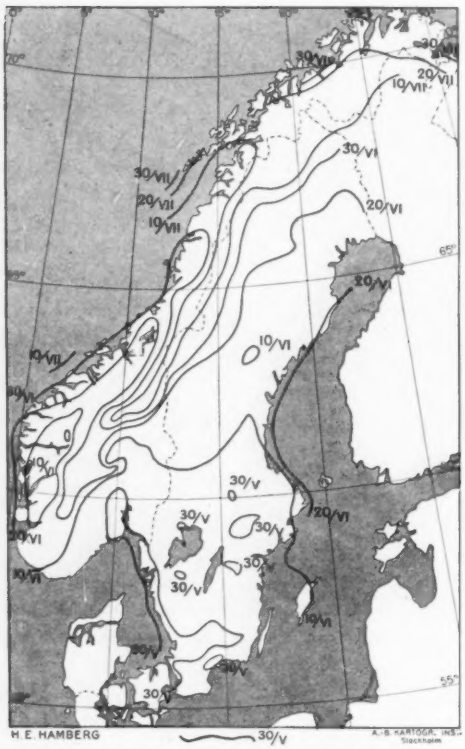


FIGURE 7.—The Isotherms of Early Summer in Scandinavia. The map shows the course of the isotherm 54° F. at the opening of the summer, reduced to sea-level. (According to Prof. H. E. Hamberg, Stockholm.)

excellent soil has developed in the upper valleys, but of limited extent.

## CLIMATE

Though climate plays only a secondary part in the distribution of improved land, this influence varies considerably over Scandinavia. Consequent upon Scandinavia's extent over more than fifteen degrees of latitude, an extent equivalent to the distance from Lake Superior to the Gulf of Mexico, the climate from Denmark to northern Norway becomes increasingly colder. The variations due to latitude are accentuated by the high axial mountain range of the Scandinavian peninsula, which lies across the path of the mild westerly winds. As a consequence of these factors, the summer period of southern Sweden is 142 days, the winter but 72 days; in northern Sweden this condition is quite reversed, with 88 days summer and 186 days winter; while in Stockholm, lying between the two, the summer lasts 124 days, and the winter 121 days—almost equal. The brevity of the northern summer is somewhat compensated for by the long daily sunshine of the summer season—in northernmost Scandinavia the mid-summer day is two months long!

As a consequence of the beneficent influence of the mild Gulf Drift, with its resultant favorable distribution of at-

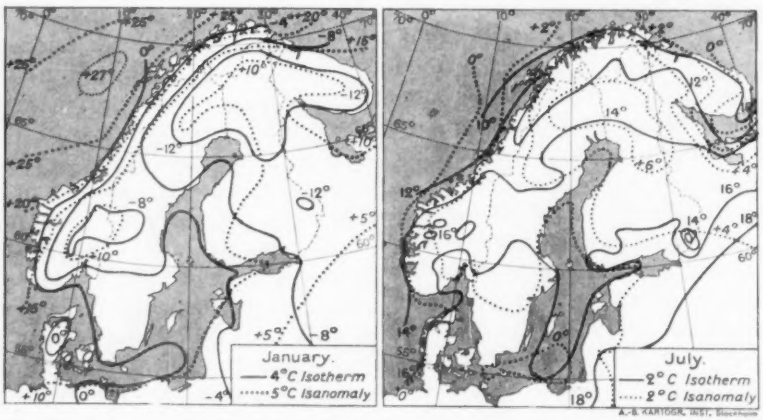


FIGURE 8.—The Influence of the Gulf Drift upon Scandinavian Climate. The isotherms and isanomalies indicate the significance of the Gulf Drift upon the climate of Scandinavia. This effect is emphasized in the winter half of the year, and most pronounced in January, when the divergence of the mean temperature in Scandinavia from the normal for their latitudes is the greatest in the world. The maximum January isanomaly north of Lofoten, indicates an excess of temperature for that latitude of 49.6° F. (27° C.). For Stockholm the January excess temperature is 23.4° F. (13° C.).

mospheric pressures, the winter temperatures of the west coast and certain interior portions of the peninsula are relatively high, and all Scandinavia has a milder and more equable climate than any other land in the same latitude.

### PLAINS IMPROVED

In such a land as Scandinavia, the topography is a primary influence in the utilization and the improvement of the land while soil and climate are of secondary importance; that is the plains, with their surface of loose materials, especially clay, lead to complete use of the land. In other regions like Alaska, California, Australia, and India, climatic conditions of precipitation and temperature determine the utilization of the land; but in Scandinavia, certain topographic relationships govern.

The plains are not necessarily more fertile than the moraine areas of Scandinavia. In fact, in some places the moraines are very fertile indeed, much more fertile than the compacted clay soil of certain areas of plain; but in the stressed economic conditions resulting from the recent industrialization of Scandinavia, it has been more profitable to cultivate more intensively the lands of the plains than to attempt to cultivate the rockier, ruggeder moraine lands. More labor and capital are required to increase production by bringing the moraine lands under tillage than by more intensive utilization of the plain lands. Once the moraine lands are cleared of the stones and brought under the plow, the labor and capital necessary to maintain their productivity may not rise above the cost of intensifying the utilization of the plain lands, and so the maps indicate a somewhat denser population on the moraine lands than might be expected. Because of historical and transportation factors, these areas are more numerous in the South than in the North.

FIGURE 9.—Pumpkins, squashes, and guerkins grown at Boden near the Arctic Circle.

## POPULATION DENSITY

The densely populated districts, with their remarkably uniform number of 50–75 inhabitants to the square kilometer, are coincident with the open, level, cultivated districts of Denmark, South and Central Sweden; around the fjords of Oslo, Trondhjem, and Stavanger; and around Lake Mjösen in Norway and Lake Siljan and Lake Storsjön in Sweden; and finally with broader river valleys in south and central Norway, the eastern part of the Swedish province of Norrland, and west and south Finland.

How much of the total area of Scandinavia is occupied by the most notable densely populated districts, largely in the regions of Cretaceous and Cambro-

TABLE 1. UTILIZATION OF THE LAND AREA OF SCANDINAVIA, 1923

| | *Area in 1,000 Hectares* | *Percentage of Total Area in* | | | |
|---|---|---|---|---|---|
| | | *Cultivated Land* | *Pasture and Meadow* | *Forest* | *Other Land* |
| Norway | 30,941 | 2.2 | | | |
| Denmark | 4,302 | 62.2 | 12.8 | 8.5 | 16.5 |
| Finland | 33,227 | 6.1 | 3.7 | 90.2 | |
| Sweden | 41,058 | 9.3 | 2.2 | 59.9 | 28.6 |
| Skåne (in So. Sweden) | 1,098 | 54.8 | 3.3 | 33.2 | 8.7 |
| Norrland (in No. Sweden) | 24,417 | 2.0 | 2.3 | 54.6 | 41.1* |

* Mostly rocks and swamps; partly arctic or alpine in character.

Silurian rocks, cannot be accurately stated, but probably about 10 per cent. The percentage is greater for Denmark and southern Sweden, where it rises to at least 60 per cent; and smaller in Norway, Finland, and northern Sweden, where it falls to 2 per cent, 6 per cent, and 2 per cent respectively.

In Sweden as a whole the densely populated districts constitute about 7 per cent, while the cultivated land occupies 9 per cent. The 2 per cent discrepancy may readily be ascribed to small scattered tracts and cultivated peatlands, in the morainal country where has developed a sparse population.

FIGURE 10.—Hay shocked to dry, on a former peat bog now drained, improved, and cultivated, in northern Sweden. Much of the present increase in improved farm-land in Sweden is due to the drainage of bogs, and lakes.

### EMIGRATION AND POPULATION

Since 1865 when the rural population of Scandinavia relatively as well as absolutely was at its maximum, the density even in the more densely populated rural districts, has decreased continuously and notably, partly as a consequence of foreign emigration, and partly because of the general industrialization of Scandinavia and because of the introduction of improved machinery and improved technique. The emigration movement has, however, been largely from the sparsely populated forest sections, and the hundreds of abandoned crofts and hamlets bear mute witness throughout the wooded areas of these lands to the line of the world's industrialism.

## A NATURAL WOODLAND

With the exception of Denmark and southern Sweden, where the cultivated land comprises over half the area, Scandinavia is essentially a natural woodland, and is destined to remain so. Its sparse population and its low percentage of tillable land, as compared with Europe as a whole, indicates that this condition will not, and cannot change.

### INCREASE OF CULTIVATED LAND

It may be said, however, that some land is still being brought into cultivation and more may be available in these countries, but that the first requisite for

an estimate of the potentially arable land is the knowledge of the extent of such land not now being tilled.

### POTENTIALLY ARABLE LAND

The conditions vary considerably in the countries of Scandinavia, both as to the information available, and the actual areal extent of the non-cultivated lands. In Sweden where the data for accurate estimate are most adequate, almost diametrically opposed opinions are expressed. One school argues that almost all the arable land in Sweden is now tilled, while another school argues that great areas are still available for profitable cultivation.[12] Apparently, there is some likelihood that North Sweden and North Finland have still some unoccupied arable land, and that a limited area in South Scandinavia may be drained and tilled. The remarkable recent improvement and utilization of the sandy plains of western Jylland in Denmark still continues. Within these relatively restricted tracts Scandinavian agriculture may expand in the future, but beyond these the possibilities are probably most remote.

FIGURE 11.—Six-rowed barley grown in Upper Norrland, near the Arctic Circle, and staked in shocks to dry. A characteristic Norrland farm, indicative of the high standard of agricultural technique in Sweden.

### POSSIBILITIES OF FURTHER IMPROVEMENTS

For the next few decades, the Swedish and Finnish governments will be able, by careful and well-organized colonization and utilization of available tillable lands now occupied by forests, to provide food for their increasing populations; but the degree to which this can be carried depends in a most intimate way upon

[12] Recently Emil Haglund has made some systematic surveys of the potentially arable land in Norrland and the geographically related and contiguous province of Dalarne. The results have been published under the following titles: "Redogörelser för inventering av odlingsjord" (Statens offentliga utredningar 1922: 32) (Report of the Investigation of Arable Land); and "Inventering av odlingsjord längst inlandsbanan" (Statens offentliga utredningar 1923: 25) (Investigation of arable land along the inland railway).

Haglund's surveys indicate that Norrland and Dalarne may have about 1,100,000 hectares arable land, of which about only one third is now cultivated.

industrial wages and the price of food products throughout the world.

On the well cultivated plains of south and Central Sweden, in Denmark, and in a few naturally favored tracts in Norway and Finland, where agriculture has probably already reached the geographic limits of its possible extension and development, any natural increase of population within these areas could not be provided with food and other necessities of life by their own agriculture, and so it is only reasonable to prophesy no further increase there, while the industrialized sections must look elsewhere for their subsistence.

### Ownership Restrictions

Within the last ten years marked improvement in the effect of ownership upon the distribution of cultivated land has been brought about; yet in the coastal belt of Norrland and in the Silurian districts of Jämtland, the development of "rational" agriculture has been retarded by the tenure of some estates too large for their best utilization, and the stubborn resistance of their owners to any partition even for the common weal. On some of these estates more attention is given to the forest crop of the moraines, than to the food crops of the valleys and plain lands. Most of the great lumber companies holding valuable tillable land within their forest tracts do not develop the crop lands at all. The enactment of a recent law provides for the seizure of such arable lands by the government, under the right of eminent domain, and its sale to actual farmers, the original owner being compensated fairly for his loss.

### Increase of Cultivated Land, 1871–1923

Despite the notable depopulation of Sweden since 1865, the area of cultivated land in crops has rather materially increased, as the following table (Table 2) will show, in addition to the kind of use to which it has been put.

Similar increases throughout Scandinavia are indicated in the following table (Table 3). Also, a constant increase in population is revealed, in spite of heavy emigration and in contrast with the decrease in rural population.

TABLE 2

UTILIZATION OF THE IMPROVED LAND AREA OF SWEDEN, 1871–1920
IN 1,000 HECTARES

| *Year* | *Small Grains Sown in the Fall* | *Small Grains Sown in the Spring* | *Root Crops* | *Forage* | *Other Crops* | *Fallow* | *Total* |
|---|---|---|---|---|---|---|---|
| 1871–75 | 409 | 928 | 159 | 732 | 18 | 398 | 2,644 |
| 1876–80 | 425 | 999 | 165 | 812 | 16 | 414 | 2,831 |
| 1881–85 | 442 | 1,079 | 169 | 866 | 13 | 423 | 2,992 |
| 1886–90 | 444 | 1,171 | 178 | 996 | 8 | 408 | 3,205 |
| 1891–95 | 461 | 1,216 | 190 | 1,077 | 7 | 418 | 3,369 |
| 1896–00 | 471 | 1,228 | 202 | 1,149 | 5 | 420 | 3,475 |
| 1901–05 | 476 | 1,233 | 208 | 1,236 | 4 | 409 | 3,566 |
| 1906–10 | 482 | 1,208 | 240 | 1,318 | 3 | 379 | 3,630 |
| 1911–15 | 487 | 1,204 | 258 | 1,294 | 3 | 346 | 3,692 |
| 1916–20 | 461 | 1,348 | 277 | 1,386 | 9 | 311 | 3,792 |
| | | | IN PERCENTAGES | | | | |
| 1871–75 | 15.5 | 35.1 | 6.0 | 27.7 | 0.7 | 15.0 | 100 |
| 1876–80 | 15.0 | 35.3 | 5.8 | 28.7 | 0.6 | 14.6 | 100 |
| 1881–85 | 14.8 | 36.2 | 5.6 | 28.9 | 0.4 | 14.1 | 100 |
| 1886–90 | 13.9 | 36.5 | 5.5 | 31.1 | 0.3 | 12.7 | 100 |
| 1891–95 | 13.7 | 36.1 | 5.6 | 32.0 | 0.2 | 12.4 | 100 |
| 1896–00 | 13.5 | 35.3 | 5.8 | 33.1 | 0.2 | 12.1 | 100 |
| 1901–05 | 13.4 | 34.6 | 5.8 | 34.6 | 0.1 | 11.5 | 100 |
| 1906–10 | 13.3 | 33.3 | 6.6 | 36.3 | 0.1 | 10.4 | 100 |
| 1911–15 | 13.2 | 32.6 | 7.0 | 37.7 | 0.1 | 9.4 | 100 |
| 1916–20 | 12.2 | 35.5 | 7.3 | 36.6 | 0.2 | 8.2 | 100 |

TABLE 3

CROP UTILIZATION OF ARABLE LAND, CHANGES IN AREA, AND POPULATION IN THE SCANDINAVIAN COUNTRIES DURING THE LAST FIFTY YEARS

AREA IN 1,000 HECTARES

| | Year | Arable Land | Wheat | Rye | Barley | Oats | Mixed Cereals | Forage | Fallow | Population |
|---|---|---|---|---|---|---|---|---|---|---|
| Sweden | 1871 | 2,563 | 57 | 355 | 229 | 528 | 76 | 700 | 389 | 4,204,000 |
| | 1910 | 3,645 | 98 | 401 | 182 | 792 | 162 | 1,349 | 363 | 5,522,000 |
| | 1923 | 3,802 | 147 | 352 | 159 | 726 | 264 | 1,586 | 316 | 6,006,000 |
| Norway | 1875 | .... | 4.6 | 15.1 | 57.0 | 92.5 | 21.1 | 321.3 | ... | 1,819,000 |
| | 1907 | 740.7 | 5 | 15 | 39.9 | 106.3 | 6.2 | 507.2 | 11 | 2,336,000 |
| | 1917 | 693 | 9 | 11 | 47 | 103 | 8 | 451 | 6 | 2,570,000 |
| | 1923 | .... | .... | .... | .... | .... | .... | .... | .... | 2,732,000 |
| Denmark | 1871 | 2,199 | 57 | 247 | 303 | 370 | 33 | 884 | 188 | 1,807,000 |
| | 1912 | 2,584 | 54 | 246 | 242 | 428 | 180 | 916 | 134 | 2,802,000 |
| | 1923 | 2,622 | 83 | 232 | 279 | 454 | 207 | 1,098 | 106 | 3,268,000 (1921) |
| Finland | 1910 | 1,865 | 3 | 240 | 110 | 399 | 7 | 772 | 232 | 3,115,000 |
| | 1920 | 2,018 | 9 | 233 | 116 | 395 | 8 | 930 | 202 | 3,365,000 |
| | 1921 | .... | .... | .... | ... | ... | ... | .... | ... | 3,403,000 |

IN PERCENTAGES OF ARABLE LANDS

| | | | | | | | | | | Other Crops |
|---|---|---|---|---|---|---|---|---|---|---|
| Sweden | 1871 | 100 | 2.2 | 13.8 | 12.8 | 20.6 | 3.0 | 27.3 | 15.2 | 5.1 |
| | 1920 | 100 | 2.7 | 11.0 | 5.0 | 21.7 | 4.4 | 37.0 | 10.0 | 8.2 |
| | 1923 | 100 | 3.9 | 9.3 | 4.2 | 19.1 | 6.9 | 41.7 | 8.3 | 6.6 |
| Norway | 1875 | 100 | .... | .... | .... | .... | .... | .... | .... | .... |
| | 1907 | 100 | 0.7 | 2.0 | 5.4 | 14.4 | 0.8 | 68.5 | 1.5 | 6.7 |
| | 1917 | 100 | 1.3 | 1.6 | 6.8 | 14.9 | 1.2 | 65.1 | 0.9 | 8.2 |
| Denmark | 1871 | 100 | 2.6 | 11.2 | 13.8 | 16.8 | 1.5 | 40.2 | 8.5 | 5.4 |
| | 1912 | 100 | 2.1 | 9.5 | 9.4 | 16.6 | 7.0 | 35.4 | 5.2 | 14.8 |
| | 1923 | 100 | 3.2 | 8.8 | 10.6 | 17.3 | 7.9 | 41.9 | 4.0 | 6.3 |
| Finland | 1910 | 100 | 0.2 | 12.9 | 5.9 | 21.4 | 0.4 | 41.4 | 12.4 | 5.4 |
| | 1920 | 100 | 0.4 | 11.5 | 5.7 | 19.6 | 0.4 | 46.1 | 10.0 | 6.3 |

## CHANGES IN AGRICULTURE

The most revolutionary and radical change in the system of Scandinavian agriculture in the last century is the extension of forage crop cultivation and a corresponding related development of crop rotation. The areas devoted to winter grain and summer grain have both increased, but relatively, grain acreage has been reduced as the acreage of root-crops and forage has been increased; and because of increased rotation the fallow areas have been materially reduced. Dairying has been extended rapidly. Diversified farming with highly selected stock and crops, has led to increased yields and augmented profits; a general rejuvenation of agriculture has ensued.

### COMPARATIVE YIELDS PER ACRE

The following table (Table 4) will show how the crop yields in Scandinavia compared with those of some foreign countries in the period of 1905–1914. The crop-yields for Sweden are arbitrarily fixed at 100.

The table establishes the fact that Scandinavia (excepting Finland, where tillage methods are still rather primitive), Germany, and England, and also Belgium and Netherlands not included in the table, lead all the nations of the world in crop production. France falls considerably behind, while the rest of the European countries are still farther in the rear.

The comparison proves that Scandinavia despite its rigorous northern location and its generally unfavorable natural conditions, can produce quite satisfactory crop yields. That a northern position does not necessarily militate against a high crop yield is borne out by the fact that except for sugar beets the unit yield of crops in Canada is higher than in the

FIGURE 12.—A farmstead in Hälsingland, central Norrland, an illustration of Sweden's skill of husbandry even to the Arctic Circle.

United States. A similar relationship holds within Sweden's own borders, as shown by the following table (Table 5) of crop yield averages for 1909–1913. Norrland's unit yield is higher than the general average; yet Norrland is the northern-most province of Sweden. The table given for the natural agricultural districts outlined by E. Höijer[13] is based upon small statistical units.

TABLE 4

| | *Wheat* | *Rye* | *Barley* | *Oats* | *Potatoes* | *Sugar Beets* |
|---|---|---|---|---|---|---|
| Sweden | 100 | 100 | 100 | 100 | 100 | 100 |
| Norway* | 78 | 106 | 101 | 103 | 101 | ... |
| Denmark | 147 | 113 | 138 | 127 | 131 | 99 |
| Finland* | 53 | 72 | 51 | 56 | 41 | .. |
| Germany | 100 | 118 | 127 | 140 | 128 | 98 |
| England | 106 | 126 | 122 | 132 | 134 | .. |
| France | 66 | 73 | 85 | 91 | 82 | 84 |
| Italy | 47 | 75 | 54 | 73 | 53 | 106 |
| Roumania | 56 | 58 | 62 | 62 | 32 | 64 |
| United States | 48 | 69 | 85 | 76 | 60 | 75 |
| Canada | 62 | 77 | 99 | 96 | 101 | 71 |
| Argentine | 33 | ... | .. | 67 | ... | .. |
| Australia | 37 | 52 | 68 | 63 | 65 | .. |

* Averages for 1909–1913.

These brief tables with their compact data merely suggest the painstaking and untiring work of the scientific men and agriculturists who have built up agriculture to its present excellence and service. The adaptability of the soil; the requirements of the crops; the determination of the best crop or rotation of crops in each and every niche of Scandinavia's arable domain; the patient experiment and the daring venture; all these have played their part in Scandinavia's intimate knowledge of the possibilities of its soil, its climate, its plants, its crops, its stock, —all to the end that every farmer shall

[13] Ernst Höijer—"Sveriges Jordbruk. Vår livsmedels-produktions förutsättningar och resultat" Stockholm, 1924. This book is a brief exposition of Sweden's agriculture, past and future, with many excellent statistical data. 170 pp. Price, 3.50 Swedish crowns. Published by Koperativa Förbundets Förlag.

TABLE 5

| | *Winter Wheat* | *Winter Rye* | *Barley* | *Oats* | *Potatoes* | *Sugar Beets* |
|---|---|---|---|---|---|---|
| 1. The Scandian Plain (Skånska Slättbygden) | 129 | 128 | 132 | 137 | 112 | 102 |
| 2. The South-Swedish Plain-moraine Transition Land (Sydsvenska Mellanbygden) | 105 | 108 | 89 | 101 | 113 | 88 |
| 3. The South Swedish Highland (Sydsvenska Höglandet) | 85 | 93 | 74 | 94 | 106 | 84 |
| 4. The Islands (Öland och Gotland) | 83 | 89 | 85 | 89 | 70 | 79 |
| 5. The Plain of East Gothland (Östgöta slätten) | 97 | 111 | 104 | 109 | 94 | 92 |
| 6. Plains of West Gothland (Västra Sveriges Slättbygder) | 83 | 102 | 86 | 101 | 100 | .. |
| 7. The Southern Bergslagen (Södra Bergslagen) | 78 | 92 | 77 | 101 | 93 | .. |
| 8. Lake Mälaren and Lake Hjälmaren District (Mälar och Hjälmarbygden) | 80 | 95 | 90 | 104 | 76 | .. |
| 9. The Northern Bergslagen (Norra Bergslagen) | 77 | 92 | 94 | 94 | 95 | .. |
| 10. The Coastal Land of Lower Norrland (Kustlandet i nedre Norrland) | 96 | 108 | 97 | 103 | 97 | .. |
| 11. The Coastal Land of Upper Norrland (Kustlandet i övre Norrland) | .. | 123 | 100 | 100 | 116 | .. |
| 12. Coastal-moraine Transitionland of Norrland (Norrländska Mellanbygden) | .. | 100 | 90 | 92 | 101 | .. |
| 13. The Silurian District of Jämtland (Jämtländska Silurområdet) | .. | 121 | 120 | 118 | 138 | .. |
| 14. The Mountain and Moraine District (Fjäll och Moränbygden) | .. | 107 | 105 | 106 | 124 | .. |
| Total Sweden | 100 | 100 | 100 | 100 | 100 | 100 |
| * 19.9 dt./har. or 29.6 bu./a. | 14.9 dt./har. or 23.7 bu./a. | 17.1 dt./har. or 31.8 bu./a. | 14.2 dt./har. or 39.6 bu./a. | 119.8 dt./har. or 178.1 bu./a. | 275.1 dt./har. or 409.1 bu./a. | |

* "dt./har." indicates the number of deciton per hectare, and "bu./a." indicates the number of bushel per acre.

know best what and how and when to do, that he may furnish food for himself and Scandinavia's workers.

Even in this brief article it is essential to an understanding of the significance of the profound change and the great progress in Scandinavia's agriculture, particularly in South Sweden and Denmark,[14] to appreciate its intimate relation to the world wide industrial revolution. As a consequence of this revolution in the world's industries a more intensive utilization of the lands already under cultivation was necessitated; but more significant was the almost incredible expansion of agriculture over the vast, virgin grasslands of newly opened foreign countries beyond the four seas.

As industry has developed the problem of exchanging the surplus production of the millions of workers in the mills and mines and factories for food, particularly, has become more acute. Generally speaking, animal foods can not be transported far. This and other factors, like high land values, have led to the monopolization by dairy interests of the arable lands within a highly industrialized region. The profits from land utilization are not derived directly from cereal production, but indirectly from milk, butter, eggs, fresh beef and pork, and other similar products. By modern methods of refrigeration it is of course possible to transport these products across the tropic seas from the grasslands of the southern hemisphere to the industrial centers of the

[14] Jonasson, Olof—"Jordens industri-och jordbruks-omraden samt varuutbytet dem emellan." ("The industrial and agricultural regions of the world, and the interchange between them"), Globen, December 1923, No. 8.

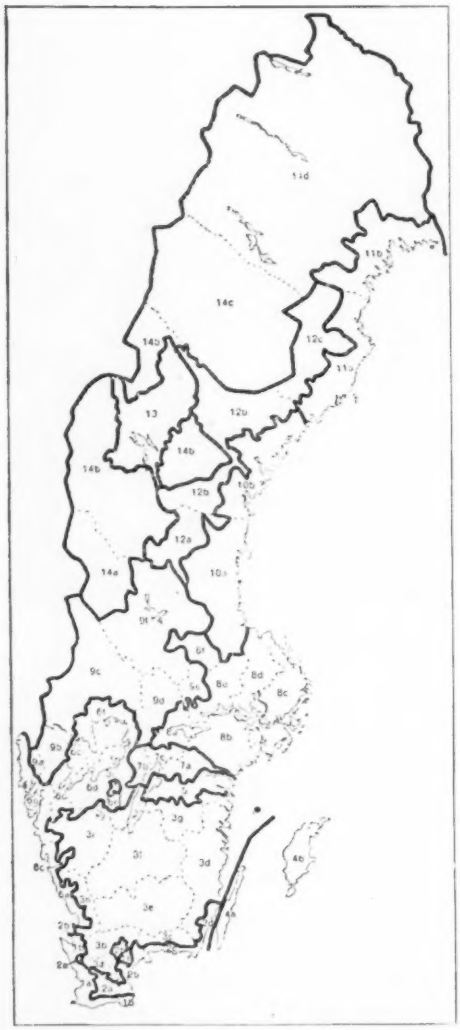

FIGURE 13.—Map of the Natural Agricultural Regions of Sweden numbered in accordance with Table 5 and based on small statistical units according to Ernst Höijer.

northern lands, but the quantity thus obtained by the manufacturing and commercial cities is relatively insignificant.

Since it is most profitable to devote the land in and about industrial regions to the most intensive use, and dairy and poultry farming are most intensive, it follows that crops are not grown directly for man's food, but for the cattle which are to yield the more concentrated, and so the most valuable foods. This explains why in Denmark, for example, in close proximity to the great industrial section of England and northwest Europe, growing of wheat has given way to the growing of oats, and why the most important export is butter (over $60,000,000 a year by pre-war figures).

As a contrast, Argentine furnishes an illuminating example of extensive agriculture where industry is undeveloped and land cheap. The most important crops are wheat and corn, not so much

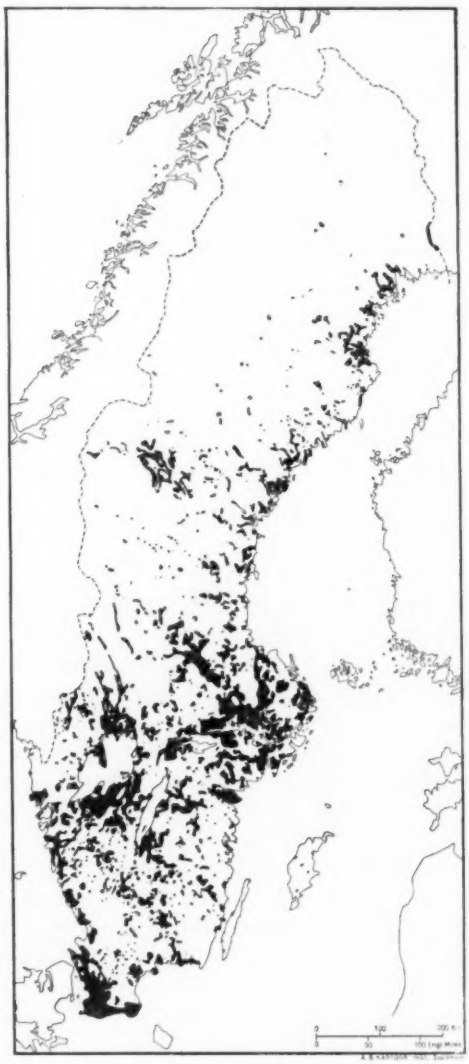

FIGURE 14.—Electrification in Sweden. A comparison of this map with those of population and cultivated land indicates how generally and extensively the farms are electrified in Sweden.

because the climate and soil are favorable, but because they yield the highest profits in the markets of the world. Dairy products, especially milk, could not, with present forms of transportation, be profitably exported across the ocean. Likewise rye and barley would find no transatlantic market. The imported Argentine wheat is converted directly into flour for man's use, but the corn is fed to swine, and only as pork becomes part of his dietary.

Since in comparison with the high-priced lands of Europe, the farmlands of the prairies, the pampas, the steppes, the veldt, or the bush, are very cheap, the problem of agriculture becomes that of obtaining the largest crop with minimum labor and capital without regard to the extent of the land used. In western Europe for a long time and in northeastern United States more recently, the land has been so highpriced that the problem has been to obtain maximum crop upon minimum land, even with great expenditure of labor and capital.

In these facts lies the explanation why the crop yield per acre in northeastern Europe is uniformly three or four times as large as in the transmarine agricultural regions of limited industry.

## SCANDINAVIA AS A MANUFACTURING REGION

The development of Scandinavian agriculture has accordingly been most closely dependent upon the nineteenth century industrialization of the civilized world. Strictly an agricultural region until the middle of the nineteenth century, Scandinavia has since changed to a dominantly industrial and commercial section of primary significance in the world's economy. The metamorphosis began with the commercial expansion of the eighteenth century, but did not progress actively until the beginning of modern manufacturing.

TABLE 6

THE NUMBER OF INHABITANTS, IN THOUSANDS, ENGAGED IN VARIOUS INDUSTRIES IN SWEDEN, NORWAY, AND FINLAND, FROM 1751 TO 1910

| | | *Farming, Fishing, and Forestry* | *Manuf. and Mining* | *Commerce and Trade* | *Independent Crafts* | *Total* | *In Percentage of Population* I | II | III | IV |
|---|---|---|---|---|---|---|---|---|---|---|
| Sweden.... | 1751 | 1,425 | 137 | 32 | 191 | 1,786 | 79.8 | 7.7 | 1.8 | 10.7 |
| | 1800 | 1,826 | 266 | 39 | 186 | 2,347 | 79.1 | 11.3 | 1.7 | 7.9 |
| | 1840 | 2,539 | 268 | 69 | 262 | 3,139 | 80.9 | 8.5 | 2.2 | 8.4 |
| | 1870 | 3,004 | 605 | 211 | 348 | 4,169 | 72.1 | 14.5 | 5.1 | 8.3 |
| | 1880 | 3,092 | 796 | 326 | 351 | 4,566 | 67.7 | 17.4 | 7.2 | 7.7 |
| | 1890 | 2,943 | 1,059 | 427 | 356 | 4,785 | 61.5 | 22.1 | 8.9 | 7.5 |
| | 1900 | 2,795 | 1,446 | 544 | 351 | 5,136 | 54.4 | 28.2 | 10.6 | 6.8 |
| | 1910 | 2,673 | 1,785 | 747 | 317 | 5,522 | 48.4 | 32.3 | 13.5 | 5.8 |
| Norway... | 1801 | 757 | 51 | 21 | 55 | 883 | 85.6 | 5.8 | 2.4 | 6.2 |
| | 1865 | 1,255 | 265 | 85 | 98 | 1,702 | 73.7 | 15.6 | 5.0 | 5.7 |
| | 1920 | 1,201 | 787 | 400 | 261 | 2,650 | 45.4 | 29.7 | 15.1 | 9.8 |
| Finland... | 1880 | 1,542 | 135 | 63 | 321 | 2,061 | 74.8 | 6.6 | 3.0 | 15.6 |
| | 1920 | 2,020 | 460 | 210 | 415 | 3,105 | 65.1 | 14.8 | 6.8 | 13.3 |

The foregoing table summarizes forcefully how this economic transition has proceeded, and demonstrates how effectively the population has been distributed among the industries.

From this table it is evident that until the middle of the nineteenth century the industrial composition of the population varied but little; about 80 per cent of the total population of Sweden was agricultural, 10 per cent industrial, and 2 per cent commercial. Since 1870 the change has been most extensive.

Sweden is now more highly industrialized than the rest of Scandinavia, with 52 per cent of its population engaged in mining, manufacturing, and commerce. In Norway the per cent is 45 and in Finland it is 22. No figures for Denmark are available. Only England, United States, Germany, Austria, and Belgium outrank her in this respect, while she outranks France, Italy, Spain, Holland, and Switzerland.

# BOOK REVIEWS

UKERS, WILLIAM H. *All About Coffee.* xxix and 796 pp.; maps, diagrs., ills., chronology, bibliography, and index. The Tea and Coffee Trade Journal Company, New York, 1922. $15.00. 10½ x 8 inches.

If there be anything left unsaid in his book about the history, the botany, the geography, or the economics of coffee, it would be hard to imagine what it could be. The product of more than seventeen years research, travel, and study by the author, and the culmination of twenty years' thought and work in this field, the book is an incomparable collection of facts, and interesting data.

To the teacher or student of economic geography it is a mine of accurate, authentic information on one of the most important commodities in the trade of the world; to the historian it is an illuminating account of one of the significant factors in the development of our culture; to the botanist, the chemist, the microscopist, the physician, to all these, some of its chapters will be the last word in his own particular field of interest in coffee; and to the geographer it constitutes the most complete authority on the production and consumption of coffee, its transportation, its preparation, its distribution, and its influence in world markets and world relations yet published. Probably a more comprehensive book on coffee will never be printed.

The book is richly illustrated by map and picture and diagram, all of the highest workmanship. The organization of the material from the Coffee Thesaurus at the beginning to the comprehensive Bibliography at the end is unsurpassed. The final index is elaborately complete. The whole volume is a credit to the author and to the company producing it.

W. ELMER EKBLAW.

WHITBECK, R. H. *Industrial Geography.* 608 pp.; maps, charts, ills. American Book Company, 1924. 8 x 5½ inches.

Professor Whitbeck has succeeded admirably in organizing the great mass of available material in the field of economic geography, always a problem to the busy teacher. In using the word industrial as the limiting term in the title of his book, Professor Whitbeck gives the word the broad significance that it should bear, to include agriculture, commerce, and transportation, as well as manufacturing.

The subject matter is well treated. After a brief consideration of the complex relationships in modern industrial activities, the author takes up the industries of the United States and devotes half the books to this field, giving clearly the place of the United States in world industry. Though the treatment is by commodities, the regional setting is skillfully depicted and duly emphasized.

In the remaining chapters industry throughout the rest of the world is treated in a masterful way by a combination of commodity and regional presentation.

Numerous maps and diagrams throughout the book enhance the clarity and unity of the treatment. Professor Whitbeck deserves the gratitude of all teachers of economic or industrial geography for the inspiration, stimulation, and valuable help that his book affords.

W. R. MCCONNELL.

PATTON, M. J. *Natural Resources of Quebec.* 133 pp.; maps, tables, ills. Natural Resources Intelligence Service, Department of the Interior, Canada. Ottawa, Canada, 1923. 9¾ x 6½ inches.

This publication just issued by the Department of the Interior of Ottawa, will prove of very timely interest. Perhaps nowhere else within the covers of a single volume can there be found such a readable and concise description of the principal natural resources of the province as in this booklet of 130 odd pages, well illustrated with photographs and maps.

Of special interest are the chapters on the pulp and paper industry, water powers, and the agricultural and mineral resources, including the new Rouyn gold fields. The scenic resources and the attractions offered to sportsmen and tourists are treated in detail. The chapter entitled "The Land and the People" is singularly successful in conveying the local atmosphere which imparts to the people and the institutions of the province their quaint attractiveness and peculiar charm.

One of the remarkable things brought out by the book is the number of features in which the province stands first or in which it excels. For example, Quebec produces seven-eighths of the world's asbestos. The first centrifugal cream separator to be used on this continent was operated in Quebec at the village of Ste. Marie de Beauce in 1882. Canada's first paper mill was established in St. Andrew's, Quebec, in 1803. Fifty per cent of the capital invested in Canada in the pulp and paper industry is invested in Quebec, and the province has within its borders over one-third of the water power that can be produced in Canada. It was in Quebec, at the Oka Institute, that the first "frost-resisting" breed of poultry, the Chanteclere, was developed to withstand cold winter weather. More maple products are made in Quebec than in all the other provinces of Canada combined and the only known workable deposits of kaolin or china clay in Canada are found there. Finally, the province boasts the largest water power storage reservoir in the world, the Gounin Dam on the St. Maurice river with 160 billion cubic feet capacity.

The publication is replete with useful information and should do much to make Quebec better known and to stimulate interest as well as the investment of capital in the development of her natural resources.

LANGDON WHITE.

COWDRICK, EDWARD S. *Manpower in Industry.* x, 388 pp. Henry Holt & Company, 1924. (American Business Series.) $3.25.

This work is a sympathetic approach to a phase of the industrial question that has engaged the attention of students in increasing degree in the past decade. The author sets forth briefly in his introductory chapter ten aspects of the problem of manpower. These are "considered, not formally or in order," in the forty short chapters which follow. These ten aspects are discussed, however, in such a way as to comprehend most of the topics included under the broad heading of labor problems.

Industrial changes, particularly in England, which intensified labor issues, are summarily contrasted with the counterforces in America of an economic and geographic nature, especially the abundance of land and natural resources—the "economic alternative"—which retarded the acute development of these problems during most of our national existence. The forty-one chapters vary widely in quality. To the reviewer, the treatment of industrial justice (chapter XII) appears futile, but chapters setting forth the strategic importance of the foreman (chapters XIX and XX) are conspicuously good. That upon the salaried employee (chapter XVIII) is not only excellent, but presents the case of a type of "labor" frequently overlooked by writers on the subject. The chapter on wages (chapter XXXIV) is a splendid example of concise summary and clear and compact reasoning.

The work contains nothing that is new to students in the field, but it contains much that every worker, every employer and every member of the public should know; and, we may add, much that many students should know better. The book deserves a wide reading.

S. J. BRANDENBURG.

VAN METRE, THURMAN W., PH.D. *Economic History of the United States.* viii, 672 pp. New York: Henry Holt & Company, 1924.

The seven parts of this little textbook are devoted respectively to the Introduction, The Colonial Period, The New Nation, The American System, The Occupation of the Great West, Large Scale Production, and Industrial Combination and Government Regulation. The subject matter of the various parts is treated topically, by chapters, rather than chronologically.

In spite of the fact that rather more than one-third of the book is devoted to the period prior to 1819, from the standpoint of balance and proportion it is distinctly superior to the majority of the books in the field. Unlike numerous earlier writers who have essayed the difficult task of compressing the economic history of the United States within the covers of a small volume, Professor Van Metre has not lost the larger and more significant movements in the maze of detail which confronts the writer on every hand. Thus, in four chapters of moderate length, entitled respectively, Industrial Combination, Government Regulation of Business, Economic Progress, 1897–1914, and Economic Effects of the World War, the author gives a clear and concise presentation of the complicated developments of the last generation. In the performance of a task, the prime qualification for which is the ability to discriminate between essentials and non-essentials, Professor Van Metre has succeeded admirably.

Thoroughgoing approval of the more important features of the book, however, does not imply that the author is not open to adverse criticism. Although he says (p. 323) that "a resistless drive toward the West has been an outstanding feature of American history since the beginning of colonization," it may be doubted whether he gives due emphasis to the influence of the westward movement, and a continent of cheap or free lands, upon the social and economic development of the American people.

In his discussion of the discovery of America (chapter II), the author appears to ignore completely the interesting point of view advanced by Professor Lybyer, a view which, while it may not be accepted, cannot be disregarded. Nor does he take cognizance of the view of Professor Wertenbaker regarding the preponderance of the yeomanry in seventeenth century Virginia.

In the chapter entitled "Crisis and Constitution," Professor Van Metre does not give sufficient prominence to the contributions of Beard and Libby to an understanding of the economics of the struggle over the framing and ratification of the Constitution. Contrary to the impression conveyed by Professor Van Metre in his discussion of the beginnings of the tariff controversy subsequent to the War of 1812, the opposition of the maritime interests of the Northeast to the protectionist policy probably resulted quite as much from the duty upon shipbuilding supplies as from their belief that protection would militate against the sea-borne trade of the United States.

The economic depression of the eighties and nineties, which culminated in Populism was quite as widespread in the South as in the West, and the former was probably more permanently influenced by the Populist movement than the latter. Finally, the conditions and forces which brought the Conservation movement to the front are worthy of more careful treatment. But these are minor faults which do not detract seriously from the general excellence of the book.

The value of the work as a textbook is enhanced by the character of the material included in the bibliographical notes. It is the author's belief that the student should widen his background by making the acquaintance of works of "fiction, travel, description, biography and autobiography" which touch upon the economic life of the country, and he has included numerous works of that character in his suggestions for collateral reading.

JAMES B. HEDGES.

ALLEN, FREDERICK J. *The Shoe Industry.* xxxvii, 415 pp. Henry Holt & Company, 1922. (American Business Series). $4.00.

For all who make, sell or repair shoes, or who wish to do so, for all who have an intelligent curiosity or an active interest in these processes, in fact, for all who wear shoes, this book contains much that is worthy of attention. The purpose of the book is "to give the nature, history, magnitude, operations and processes, employment opportunities and demands, earnings, and the probable future of the industry" (Preface, p. iv). The author's interest in vocations, both academic and practical, extending through many years, fits him conspicuously well for carrying out this purpose.

The work summarizes the history of shoes, of shoe-making, and the development of shoe-making machinery. It devotes a chapter to the organization of the factory and to its typical layout. Separate chapters are devoted to each of the several important departments, such as the stitching department, the sole leather department, etc.; also to shoe repairing and the shoe findings industries. The continued dominance of New England, and particularly of Massachusetts, in the industry is noted; too little attention, it appears, is given to the geographic and economic conditions which have led to the development of important new centers of the leather trades in regions further west.

To the teacher perhaps the most valuable sections of the book are those discussing the vocational aspects of the shoe-making trade. Teachers fond of using the shoe industry to illustrate the principles and economy of technical division of labor should be happy to be authoritatively informed that "in making an ordinary shoe today there are one hundred and seventy-four machine operations, performed upon one hundred and fifty-four different machines, and thirty-six hand operations, or altogether two hundred and ten processes. About three hundred different machines are used in the manufacture of all kinds of footwear, and the number of processes is considerably increased" (pp. 41-42). Positions in the various departments and the duties pertaining to each are briefly described. Training courses for entry into the trade,—their duration, content, cost and value to the learner and to the industry,—are concisely set forth. Typical conditions of employment, statistical data as to wages, hours, age and sex distribution of workers, opportunities for advancement, and for handicapped workers receive attention.

Diagrams, charts, illustrations, glossary and bibliography add to the value of the work, though some of the illustrations fail to make clear the machine processes involved. Also the usefulness of the book as a convenient tool for ready reference is somewhat lessened by a poorly arranged index (*e.g.*, the unexpected heading, "Census Statistics"); and the work is marred by occasional faulty sentence construction (*e.g.*, p. 50 and elsewhere). These are minor defects, however. Students of industry, both in its academic and practical aspects, should welcome this and similar handbooks descriptive of other important enterprises.

S. J. BRANDENBURG.

MC FARLANE, JOHN. *Economic Geography.* Second edition, revised and enlarged. 640 pp., 20 maps, index. Sir I. Pitman & Son, London and New York. $3.00.

This is a textbook which treats regionally the economic geography of the world. The first three chapters (40 pp.) review briefly in a general way: (1) the relation of land forms to the economic activities of man, (2) the relation of the origin of rock formations and of morphological processes to the utilization of land and water, (3) the principles of climate, and (4) the influence of natural environment on the distribution of vegetation. These concisely written chapters are easy to read, and contain much material which is valuable in interpreting the remainder of the book.

The remaining 600 pages are given to a study of regional geography. The author divides the countries of the world into natural regions, and traces the influence of the geographical conditions of each upon the economic activities of men within it. On the whole, he has done an excellent piece of work. The regions seem to be well selected and the major economic activities of men stand out in relation to the environment.

A wealth of material is compressed into one volume. Maps indicating some of the natural regions accompany the text. However, many of the regions are not so indicated, and a few are indefinite and difficult to locate. This, perhaps, is inevitable in such a comprehensive undertaking as a regional discussion of the world with the very limited data which are available for some areas.

Although most of the material given for each region is well chosen and to the point, occasionally the author throws in the names of geological formations which make reading difficult and which give little or no aid in geographical interpretation (pp. 47–48). It is true that a student with considerable knowledge of geology would be able to draw some inferences concerning the economic importance of a detailed enumeration of rocks, but it is difficult to understand why the author names the geological formations in some regions and ignores them in others.

A summary of foreign trade is given for each country except those of minor importance or those created since the World War. The statistics are for years prior to 1914.

It is to be regretted that a book which gives such a large amount of valuable information on regional geography has no bibliography.

EARL C. CASE.

# OUR CONTEMPORARIES

THE GEOGRAPHICAL REVIEW

Vol. XV, No. 1, January 1, 1925

**The Distribution of Population in China: Economic and Political Significance.** 24 pages. Percy M. Roxby.

An exceedingly interesting presentation of the essential facts in a population study of China; of the economic and political aspects of the distribution of population; and of the geographic influences that should be decisive in the development of the Chinese nation. Richly illustrated by maps, charts, and pictures.

**The Value of Alaska.** 26 pages. Alfred H. Brooks.

The most compact and illuminating article on Alaska published in many years, by the most competent authority. The natural resources, the industries, and the future development of Alaska are all excellently presented. Superior illustrations, maps, and charts accompany the article. The American Geographic Society honors itself as it honors the memory of the author by the care taken with the entire article.

**The Trans-Saharan Railway.** 19 pages. E. F. Gautier.

The Trans-Saharan Railway opens up a vast territory about which little has been definitely known until recently; this article contains a fund of information invaluable to the geographer. It is richly illustrated.

**The Kingdom of the Serbs, Croats, and Slovenes.** 14 pages. Vorivoje L. Milojevic.

A discussion of the Administrative Divisions in Relation to Natural Regions.

**The Region of Mount Logan, Gaspe Peninsula.** 8 pages. J. Franklin Collins and Merritt L. Fernald.

**The Great Desert: An Appreciation of E. F. Gautier's "Le Sahara."** 14 pages. G. M. Wrigley.

One of the finest discussions of the problem of the utilization of the desert and similar marginal lands, published in recent years.

**Effects of Tropical Cyclones upon the Weather of Mid-Latitudes.** 9 pages. Stephen Sargent Visher.

**Plans for Exploration at the Headwaters of the Branco and Orinoco.** 8 pages. A. Hamilton Rice.

**Geological Significance of Isostasy and Gravity Measurements: A Review.** 7 pages. Chester R. Longwell.

**American Geographical Society.** (Activities).

**Geographical Record.**

**Geographical Reviews.**

THE BULLETIN OF THE GEOGRAPHIC SOCIETY OF PHILADELPHIA

Vol. XXIII, No. 1, January, 1925

**Geographic Influences in the Routes and Traffic of the Atlantic Railway Connections at Montreal.** 12 pages. Clarence F. Jones.

Dr. Jones presents in an interesting way the adaptation of the transportation system of eastern Canada to the natural environment, as well as the economic and political influences that have affected the routes chosen.

**Economic Geography of Canadian Asbestos.** 9 pages. Floyd A. Stilgenbauer.

The asbestos industry of Canada is unique, in that it is a monopoly product of high value, operated with little labor and a comparatively small amount of capital; that it is favorably located, in a small compact area, for both land and water distribution; and that its product has a large number of uses for which no substitute has been discovered.

**The Port of Halifax.** 11 pages. Lester E. Klimm.

Halifax will share largely in the trade resulting from increasing manufacturing in Nova Scotia. The port is accessible to great water power, to tidewater coal and iron resources, and to the agricultural hinterland. Halifax will grow as a mail and passenger port and as a trading and manufacturing center.

**Book Reviews.**

**Geographical News and Notes.**

**Activities of the Society.**

THE JOURNAL OF GEOGRAPHY

Vol. XXIV, No. 1, January, 1925

**Czechoslovakia: Factors of Geographic Unity.** 10 pages. Bessie C. Engle.

The geographic material in this article is dominantly economic, with considerable political significance. The adjustments of agriculture to the natural conditions of the country form the main part of the paper.

**The Present Status of Navigation on the Lower Mississippi River.** 10 pages. C. A. McCombs.

An interesting paper on river traffic as related to the rail traffic of the Mississippi Valley.

**Concerning Latitude and Longitude.** 3½ pages. Ella M. Wilson.

**Weather Maps and Forecasts.** 3 pages. Emmarene Bullock.

**Variations Among the States in Wealth.** 4 pages. Stephen S. Visher.

**Muscle Shoals.** 4 pages. Ralph H. Brown.

A study in the utilization of resources.

**In the Wake of the World Fliers.** 3 pages. George F. Howe.

**Editorial: "As Others See Us."**

**Geographical Publications.**

THE JOURNAL OF GEOGRAPHY

Vol. XXIV, No. 2, February 1, 1925

**The Changing Role of the Kentucky Mountains and the Passing of the Kentucky Mountaineer.** 11 pages. D. H. Davis.

General geography with considerable emphasis on the economic adaptation of the life of this region to the natural conditions.

**The Scandinavian Peninsula.** 14 pages. Frederick K. Branom.

A generalized study, essentially economic, for the use of the teacher, that summarizes well the geographic influences in the activities of the Scandinavian peoples.

**Geographic Principles in the Study of Cities.** 39 pages. Douglas C. Ridgley.

A valuable pedagogical presentation of the geographic and economic factors in the location and development of cities.

**Editorial: "Responsibility."**

**Geographical Publications.**

THE NATIONAL GEOGRAPHIC MAGAZINE
Vol. XLVII, No. 1, January, 1925

**Seeing America from the Shenandoah.** 48 pages. Junius B. Wood.

**The Palace of Versailles, Its Park and Trianons.** 6 pages. Franklin L. Fisher.

**Versailles, the Magnificent.** 8 pages. Gervais Courtellemont.

**Chichen Itza, an Ancient American Mecca.** 33 pages. Sylvanus Griswold Morley.

**Interviewing the Stars.** 25 pages. William Joseph Showalter.

Vol. XLVII, No. 2, February, 1925

**Cairo to Cape Town, Overland.** 120 pages. Felix Shay.

**Amid the Snows and Swamps of Tropical Africa.** 16 pages.

THE NATIONAL GEOGRAPHIC MAGAZINE
Vol. XLVII, No. 3, March, 1925

**Looking Down on Europe.** 65 pages. Lieut. J. Parker Van Zandt.

**Across French and Spanish Morocco.** 30 pages. Harriet Chalmers Adams.

**The Camera's Color Records of North Africa.** 8 pages. Gervais Courtellemont.

**The Singing Towers of Holland and Belgium.** 20 pages. William Gorham Rice.

THE JOURNAL OF LAND AND PUBLIC UTILITY ECONOMICS
Vol. I, No. 1, January, 1925

**Research in Land and Public Utility Economics.** 6 pages. Richard T. Ely.

**Customer Ownership of Public Utilities.** 11 pages. Ralph E. Heilman.

**Land Ownership in England since the War.** 5 pages. Sir Henry Rew.

**Housing in the United States.** 13 pages. John M. Gries.

**Forestry and Land Development in the Lake States.** 8 pages. Raphael Zon.

**The Taxation of Public Service Industries: A Preliminary Report.** 27 pages. Herbert D. Simpson.

**Place of Tenancy in a System of Farm Land Tenure.** 12 pages. George S. Wehrwein.

**The Prevention of Economic Waste by City Planning.** 6 pages. Harland Bartholomew.

**Water—Power Situation in the United States.** 13 pages. Walter H. Voskuil.

**Farm—Mortgage Interest Rates.** 16 pages. Clara F. Wigder.

**Department Contents.**

**Book Reviews.**

**Summaries of Research.**

**Comments on Legislation and Court Decisions.**

# NEWS ITEMS

The Association of American Geographers presented a memorial to William Morris Davis on the occasion of his seventy-fifth birthday on February 12th, 1925. The memorial took the form of an embossed statement as follows:

"The Association of American Geographers extends to William Morris Davis greetings and congratulations on his seventy-fifth birthday and desires to express to him the appreciation of geographers everywhere of his years of significant, constructive work in many fields of science. He took the young and little known science of meteorology, gave it form, and made it an educational instrument. The rivers and valleys of his native state spoke to him with a new voice and inspired him to interpret the history to be read in the face of the land. Applying the same vision in many strategic areas, he produced interpretations which have been recognized by all subsequent workers as among the classics of science. He early sounded the note which today voices the spirit of modern geography as the study of life adjustments. With an enthusiasm that has never lagged, he has led colleagues, students, and the interested public to a deeper appreciation of geography, and his faith has proved well founded. With deep respect, we all join in congratulations on a life filled with significant accomplishment, and in earnest wishes for years of energy to realize more of his hopes for his beloved science."

## UNIVERSITY OF WISCONSIN

### Department of Geography

Miss Genivera Loft, Mr. John W. Frey, Mr. Ralph H. Brown are candidates for the Doctor's degree in geography this spring. Mr. Glenn T. Trewartha was granted his Ph.D. last October. The titles of dissertations are as follows:

Miss Loft's, "Geographic Influences in the Economic Development of Manitoba"; Mr. Frey's, "The Geographic Background of Certain Anglo-American Trade Relations"; Mr. Brown's, "The Economic Geography of the Middle Connecticut Valley as Illustrated by Hampshire County, Mass."; Mr. Trewartha's, "The Dairy Industry of Wisconsin as a Geographic Adjustment."

Mr. Herbert Burgy and Miss Helen Shoemaker are candidates for the Master's degree in geography this spring.

The course on Geography of Wisconsin has been resumed, with Mr. G. H. Smith as instructor.

Prof. R. H. Whitbeck is giving two new courses this year; an Industrial Geography course the first semester, and an advanced course in Geographic Principles, designed for majors in the social sciences, the second semester.

Dr. V. C. Finch was at the University of Chicago from the 3rd to 7th of February, instructing the graduate students in geography in the technique of dot mapping.

D. Ales Hrdlicka, curator of the National Museum of Physical Anthropology, was brought to Wisconsin during January by the Department of Geology, to deliver three lectures on the Evolution of Man.

Five hundred and sixty students were enrolled in elementary geography courses the first semester, and 175 in the more advanced geography courses.

Doctor A. K. Lobeck is the author of a new book entitled, "Block Diagrams."

## UNIVERSITY OF MICHIGAN

### Department of Geography

Mr. R. B. Hall is planning to make a field study of Haiti. His first trip to Haiti for a reconnaissance survey will be this summer.

The staff of the geography department is giving an advanced field course this semester in which a detailed study of a township near Ann Arbor will be carried out in coöperation with the Michigan Land Economic Survey.

An additional man has been added to the summer school staff of the geography department. Six courses will be offered, four at Ann Arbor, and two in the field camp in Kentucky.

Asst. Prof. Preston E. James, who is particularly interested in the geography of South America, completed his studies of Trinidad last summer.

## UNIVERSITY OF CHICAGO

### Department of Geography

Doctor's degrees were conferred at the end of the last summer quarter upon Mary J. Lanier and Richard Hartshorne. Dr. Lanier's dissertation was entitled "The Earlier Development of Boston as a Commercial Center." Dr. Hartshorne's investigation was concerned with "The

Lake Traffic of Chicago." Dr. Lanier has returned to Wellesley College as associate professor of geography. Dr. Hartshorne is now an instructor in geography at the University of Minnesota.

Master's degrees were conferred at the same convocation upon Will T. Chambers, Mabel Crompton, Margaret Hitch, and Mabel Schwartz. Margaret Hitch is now doing research work in Washington, D. C., where she is helping Mrs. Saucerman in collecting material for economic studies being carried forward by Mr. Goode and Dr. O. E. Baker.

Alice Crandall and Belle Strunk, both of whom took major sequences in geography, received Bachelor's degrees at the end of the summer quarter. Miss Strunk was elected a member of Phi Beta Kappa. She is now an instructor in geography in the Western State Normal School at Kalamazoo, Michigan. Miss Crandall is teaching geography and history in the Elementary School of the University of Chicago.

The first volume of "An Introduction to Economic Geography" by Dr. W. D. Jones and Dr. D. S. Whittlesey, which treats of "The Natural Environment as Related to Economic Life" appeared in final form last January. Reprints of this volume have been used in Geography 1 classes during the autumn quarter. Volume II is in course of preparation, and the authors hope to have it finished in 1926. The publishers are the University of Chicago Press.

At the Thanksgiving meeting of the Central Association of Science and Mathematics Teachers, held in Chicago, Mr. Jones conducted a field excursion for teachers of geography, with the purpose of demonstrating methods of field work with classes. Edith Parker gave an address on "The Relation of Social Studies in the High-School Curriculum to Geography," and Henry M. Leppard spoke on "The Content of High-School Geography," in which he emphasized the value of regional studies in the high school.

Dr. C. C. Colby spent last summer and part of the autumn in studying industrial and transportation problems which confront the present and future development of certain American cities. The major portion of that time was spent in the industrial cities of northeastern Ohio, the cities of the anthracite districts, and the port cities of New Jersey. Clifford M. Zierer, a graduate student in the Department, was associated with him in this work. Mr. Zierer is now engaged upon a detailed geographic study of the Scranton section of the anthracite district.

Dr. R. S. Platt has contributed a chapter on Mexico and Central America to a new edition of Chisholm's "Handbook of Commercial Geography," which will be published in the near future by Longmans, Green & Co., in London, England.

Mr. Maurice Senstius read a paper on "The Formation of Soils in Equatorial Regions, with Special Reference to Java," as an introduction to a symposium on tropical soils held by the American Soil Survey Association at their latest meeting in Chicago, last fall.

George J. Miller is the author of a series of five pamphlets of "Pupils' Outlines for Home Study," treating of: (1) North America, (2) South America, (3) Africa, (4) Europe and Asia, (5) Mathematical and Physical Geography, all published by the Jennings Publishing Co., Newtonville, Massachusetts.

"Branom Tests in Geography," by Mendel E. Branom, were recently published by Mc Knight & Mc Knight, in Normal, Illinois.

Genieve Lamson's thesis for the Master's degree has been printed by the Vermont Historical Society under the title of "Geographic Influences in the Early History of Vermont."

Ll. Rodwell Jones, Cassel lecturer in economic geography in the University of London, England, will be the guest of the Department during the Summer Quarter of 1925. He will offer a Senior College course on "Geographical Aspects of the Development of Certain Leading British Industries" and a graduate course on "Studies in the Urban Geography of the British Isles."

An interesting course in addition to the many given in the Department of Geography is the course in human ecology given under Sociology and Anthropology entitled "Human Ecology" by Associate Professor McKenzie. It is a study of the geographic and economic factors which determine the location and growth of communities; types of communities, trade and market zones, significance of changing forms of transportation and communication, population selection and composition; community structure, distribution and segregation of utilities and inhabitants.

## CLARK UNIVERSITY

### DEPARTMENT OF GEOGRAPHY

Fred K. Branom, Ph.D., Clark, 1923, has recently written for the A. J. Nystrom Co., Chicago, Illinois, two manuals for teachers upon "The Use of Maps" and "The Use of Globes."

During the week of March 2nd, Dr. Henry C. Cowles, of the University of Chicago gave a series of five lectures on the distribution and adaptation of plants to their environment. On Wednesday, March 4th, he lectured to the people of Worcester upon, "Ecology in the Settlement of Boundary

Disputes." Most of the lectures were illustrated by lantern slides.

On Monday, March 2nd, Professor Edward L. Stevenson of the Hispanic Society of America gave two illustrated lectures at Clark on "The Expansion of Geographic Knowledge in the Middle Ages and Its Record as Given by the Map-makers" and "Early Discovery and Exploration in the New World as Represented by Contemporary Map-makers."

Herman G. Patt, Superintendent of Schools at Manchester, Massachusetts, a former graduate student, is the author of an article entitled "A New Thought in School Work," in a recent number of *The North Shore Breeze*, a New England local magazine. In this article Mr. Patt shows how important geography is in one's everyday life and how all school work can be linked up through a study of that subject. Tried out in the Manchester schools, this method has proved successful in not only history and government, but also in such studies as arithmetic, geometry, and manual training.

Professor George B. Roorbach of the Graduate School of Business Administration at Harvard gave a series of six lectures on foreign trade from the geographic point of view, the second week of March.

Dr. F. X. Schaffer of the Department of Geology of the University of Vienna will be at Clark on April 1st, 2nd and 3rd. He will deliver a series of lectures, the titles of which are: "The Changes of the Main Features of the Earth's Crust," "Man of the Stone Age in the High Alps" and "Seven Travels in Asia Minor."

It is planned to have the Annual Meeting of the New England Geographical Conference and the Association of Clark Geographers on May 15th and 16th. This year Dr. William C. Alden of the United States Geological Survey will be the special guest. He has just published his paper on the Physical Features of Central Massachusetts. While at Clark he will lecture and conduct a field excursion. At the annual dinner of the Association to be held Saturday night, President James will deliver his Presidential address.

Dr. V. C. Finch of the University of Wisconsin will offer courses in the summer school.

In addition to Dr. Jones's field trip to the St. Lawrence region several other special field trips have been planned, one through eastern New York to make a special study of the Hudson River Valley.

The Atwood regional political map series—United States, North America, and Asia—are being distributed by the publishers, A. J. Nystrom and Co., Chicago, Illinois.

Dr. Clarence F. Jones is absent on an extended field trip through parts of South America. He left Worcester on January 19th and will be gone about five months. He will visit the West Coast, where considerable time will be spent in field work in Ecuador and Peru. An interesting feature of his visit to the latter country will be the "All-Daylight-Voyage" on Lake Titicaca. The great mining centers of Peru, the famous nitrate fields of Chile, and the renowned Santiago-Valparaiso region will be studied before he crosses the continent via the Transandine Railway to Buenos Aires. About twenty-five days will be consumed in travelling through the Pampa country visiting its great cities and investigating its chief industries. En route home, Dr. Jones will visit Montevideo, Santos and Rio. He will be back in time to conduct a field excursion to the Saint Lawrence Valley at the close of the Summer School.

Langdon White and Burton Merrill Varney both received the degrees of Doctor of Philosophy at the mid-year convocation. The titles of their respective dissertations were: "The Agricultural Geography of the Salt Lake Oasis" and "Seasonal Precipitation in California and its Variability." Dr. White has recently been appointed instructor in Economic Geography at Clark University while Dr. Varney continues his work as assistant editor of the *Monthly Weather Review*.

Mr. Olof Jonasson, a member of the staff at the University of Stockholm, Sweden, and of the University of Commerce in Stockholm, who because of his activity in promoting the teaching of geography in the schools of Stockholm has been favorably commended by his government, is studying at Clark. His stay in this country has included a trip to the Middle West and research work in the Department of Agriculture at Washington. Just now he is studying the distribution of small grains throughout the world.

Arthur Sibelka is studying at Clark as a representative of the Geographical Institute of Budapest. Mr. Sibelka recently gave an illustrated lecture entitled, "The Economic Geography of Hungary," before the University.

Dr. O. E. Baker of the United States Department of Agriculture is back at Clark this semester. Dr. Baker is offering two courses in agricultural geography, both of which are well attended.

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# POWER

POWER is the magic mainspring of economic progress. From that early hour in the gray dawn of history when primitive man harnessed the first dog, or rode the river current on his first crude raft, or fashioned in the hearth fire of his own cave his first metal spear-point, to the last day of this decade with its manifold marvels of airplane and automobile and submarine, of turbine and dynamo and radio, the measure of man's progress has been his ability to turn to his own use for his own good the varied natural resources at his hand.

When the delegates of more than forty nations of the earth met in conference a year ago in London to survey the power resources of the world, they represented practically every land where man can hope to prosper, almost every people that uses machinery and power in its industry and its art; but whence they came and whither they again went, they brought to that conference each his own portion of cordial coöperation, each his own portion of plan and fact and purpose to contribute to the common cause of international amity and concerted action for the weal of the peoples of the world, and took from it a vision of international partnership in power.

Like seers of a single state they surveyed the whole field of potential power; and whether they viewed the waterfalls from the equatorial plateau of Africa and the cascades from the jagged crests of the Alps, or the oil fields of America and Persia, or the coal mines of Canada and China, their broad and clear vision recognized no political boundaries, no separate sovereignties. They saw only the peoples of the world as brothers.

As Dr. Smith emphasizes in the introductory paragraphs of his trenchant summary of the situation in the leading article of this, our second issue, human interest in power is international, as is the opportunity for its utilization for the common social and economic good — there is no national isolation of power.